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ENGINEERING:

An Illustrated Weekly Journal.

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VOL. CXIV.—No. 2965.] *LONDON: FRIDAY, OCTOBER 27, 1922.* [*Registered at the General Post Office as a Newspaper.*] [PRICE ... 1s. BY FOREIGN POST 1s. 4d.

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See Illustrated Advertisement Page 20.

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Steam and Electric Cranes,
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The Strongest Chain 888
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SHALLOW DRAFT VESSELS.
818

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for Engine Works and Boiler Shops.
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Cochran MULTITUBULAR AND CROSS-TUBE TYPES **Boilers.**
See page 17, Oct. 20. 9947

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CONTRACTING ENGINEERS.
DESIGNERS and BUILDERS
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all Classes of HANDLING MACHINERY.
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Diesel Engines, Six Cylinder,
Two and Four stroke, 850, 1000, 1200 H.P., excellent condition. Dynamos for above 250 or 500 volts, D.C. Immediate delivery and low price.
Two 500 Kw. Parsons Turbine Sets, 250 or 500 volts D.C., with condensing plant and spare armature. Price £2200.
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HEAD OFFICE: 24, Robertson Street, Glasgow.
See Advertisement page 78.

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FEED WATER HEATERS, CALORIFIERS, EVAPORATORS, CONDENSERS, AIR HEATERS, STEAM AND GAS KETTLES, } Row's PATENTS.
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SYPHONIA STEAM TRAPS, REDUCING VALVES
High-class GUNMETAL STEAM FITTINGS.
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Steel Plates.
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GLASGOW - BIRMINGHAM - LONDON.
See Advertisement Page 26. 9932

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HIGH BOILER EFFICIENCIES ARE OBTAINED BY INSTALLING
Todd Oil Burners
FUEL OIL BURNING SYSTEMS, HEATERS, STRAINERS.
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Great saving of labour. No noise. No dust. No dirt. Ashes discharged 20 ft. clear of vessel.—Apply, F. J. TREWENT & PROCTOR, LTD., Naval Architects and Surveyors, 43, Billiter Bldgs., Billiter St., London, E.C. Od 4835

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Makers of
Evaporating and Distilling Plants.
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&c. &c. 648

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Builders of RAILWAY CARRIAGES, WAGONS ELECTRIC CARS, and EVERY OTHER DESCRIPTION OF RAILWAY and TRAMWAY ROLLING STOCK.
Makers of WHEELS and AXLES, RAILWAY PLANT, FORGINGS, SMITH WORK, IRON & BRASS CASTINGS.
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Registered Office and Chief Works: Motherwell.
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LAND AND MARINE
YARROW BOILERS.
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GENERAL CONSTRUCTIONAL ENGINEERS. 1916
Boilers, Tanks & Mooring Buoys
STILLS, PETROL TANKS, AIR RECEIVERS, STEEL CHIMNEYS, RIVETTED STEAM and VENTILATING PIPES, HOPPERS, SPECIAL WORK, REPAIRS OF ALL KINDS.

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Head, Wrightson & Co.,
LIMITED.
See Advertisement page 38, Oct. 20. 2469

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See Full Page Advt., page 60, Oct. 13.

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34 & 35, PETTER LANE, LONDON, E.C. 4.
42 & 43, LIONEL STREET, BIRMINGHAM.
and Principal Provincial Cities.

Important Foundry Can Carry OUT CASTINGS, both Iron and Steel, in large series, machine moulded. Can also cast pieces up to 60 tons in weight. Any castings, iron, steel, brass and all special alloys undertaken.
Address:
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A Few Agents Required. 9078

See Advt. Page 13 Oct. 13.
Steam Hammers
Power Hammers
Steam and Friction
Drop Stamps.
B. & S. Massey, Ltd., 9911 MANCHESTER.

The Manchester Steam Users' ASSOCIATION.

For the prevention of Steam Boiler Explosions and for the attainment of Economy in the Application of Steam. 9, Mount Street, Manchester.
Chief Engineer: C. B. Stromeyer, M.I.C.E.
Founded 1854 by Sir William Fairbairn.
Certificates of Safety issued under the Factory and Workshops Act, 1901. Compensation for Damages and Liabilities paid in case of Explosions. Engines and Boilers inspected during construction. 598

No. 60439 of 1922.

IN THE HIGH COURT OF JUSTICE
CHANCERY DIVISION.
MR. JUSTICE P. O. LAWRENCE.
IN THE MATTER OF VICKERS LIMITED
and
IN THE MATTER OF THE COMPANIES (CONSOLIDATION) ACT 1908.

Notice is Hereby Given that

a Petition was on the 5th October 1922 presented to the High Court of Justice by the above-named Company for the confirmation of an alteration of the provisions of the Memorandum with respect to the Company's objects proposed to be effected by a special resolution of the Company passed and confirmed respectively at Extraordinary General Meetings of the Company held on the 19th July 1922 and the 3rd August 1922 whereby it was resolved that the objects of the Company be extended so as to enable the Company:

To carry on the business of Metal workers Iron masters, Coal owners, Brick makers, Quarry owners, Wood workers, Printers and Refiners.

To acquire, construct, equip, repair, sell and deal in locomotives, tractors, motor cars, aircraft and vehicles of every description.

To acquire, construct, manufacture, repair, sell and deal in explosives, telescopes, sights, optical and scientific apparatus.

To acquire, erect, construct, equip, maintain, work and improve tramways, railways, roads, ways, bridges, tunnels, canals, hydraulic, electric or gas works, iron, coal or other mines, smelting works and refineries, silica or other brick kilns, cement works and quarries.

To promote the use of aircraft for passengers and goods.

To manufacture, sell and deal in bye-products.

To benefit Employees. To carry on all or any of the Company's businesses in any part of the world and either as principals, agents, contractors, trustees or otherwise.

With the usual ancillary powers for the above purposes.

A print of the Memorandum of Association submitted to the said meetings containing the new Sub-Clauses proposed to be inserted will be sent on request to any creditor, secured or unsecured, or any member of the Company, and such print of the Memorandum of Association may be inspected at the office of the Company at Vickers House, Broadway, Westminster, or at the offices of the undersigned Solicitors between the hours of 10 a.m. and 1 p.m. on any weekday prior to the 14th November 1922.

AND NOTICE IS FURTHER GIVEN that the Petition is directed to be heard before Mr Justice P. O. Lawrence at the Royal Courts of Justice Strand on Tuesday the 14th day of November 1922 and any person interested in the said Company whether as Debenture-holder, Creditor, Policyholder or otherwise desirous of opposing the making of an Order for the confirmation of the said alteration under the above Act may appear at the time of hearing by himself or his Counsel for the purpose. Any such person is required to give notice in writing on or before the 10th day of November 1922 of his intention so to appear and stating the grounds of his objection to the undersigned Solicitors. A copy of the said Petition will be furnished to any such person requiring the same by the undersigned on the payment of the regulated charge for the same.

DATED this 20th day of October, 1922.
LINKLATERS & PAINES,
2, Bond Court, Walbrook, E.C. 4.
Solicitors for the above-named Company. W 620

Inst. C.E., I. Mech. E., B.Sc.,

and all Engineering Examinations.—Mr. G. P. KROWLES, B.Sc., M.E.E., A.M.Inst.C.E., F.S.I., M.R.San.I., PREPARES CANDIDATES personally or by correspondence. Thousands of successes during the last sixteen years. Courses may commence at any time.—39, Victoria St., Westminster, S.W. Tel. 4780 Victoria. 884

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Practical Course of Instruction by Correspondence.—Address, for particulars and terms, 148, Offices of Engineering.

A Brochure on "Engineering

SALESMANSHIP and SALES MANAGEMENT," with particulars of a SPECIAL COURSE of training, will be sent post free on application to DIRECTOR, The Institute of Engineering Salesmanship, 333, Oxford Rd., Manchester. 985

TENDERS.

HOPPER BARGE.

THE TRUSTEES OF SHOREHAM HARBOUR invite

Tenders for the Supply and

DELIVERY of a suitable HOPPER BARGE capable of carrying about 300 tons of dredged material. Full particulars as to age, condition and price to be sent to the undersigned on or before Saturday, 4th November, next.

The Trustees do not bind themselves to accept the lowest or any Tender.

CHANFIELD BAGULEY,
Clerk to the Trustees.
Harbour Offices, Southwick,
Brighton, 17th Oct., 1922. W 567

BENGAL-NAGPUR RAILWAY CO. LTD.

The Directors are prepared to receive

Tenders for:—

STEEL BOILERS TUBES.

Specification and Form of Tender can be obtained at the Company's Offices, 22, Gresham House, Old Broad Street, London, E.C. 2, on or after 26th October, 1922.

A fee of £1 1s. will be charged for the specification, which will not be returned.

Tenders must be submitted not later than Noon on Monday, 6th November, 1922.

The Directors do not bind themselves to accept the lowest or any Tender.

By Order of the Board,
T. R. WYNNE,
Managing Director. W 559

BENGAL-NAGPUR RAILWAY COMPANY LIMITED.

The Directors are prepared to receive

Tenders for the Following:—

1. BUFFER PLUNGERS AND CASES.
2. STEEL AXLES.

Specifications and Forms of Tender can be obtained at the Company's Offices, 132, Gresham House, Old Broad Street, London, E.C.2., on or after 23rd October, 1922.

A fee of £1 1s. will be charged for each specification, which will not be returned.

Tenders must be submitted not later than Noon on Thursday, 2nd November, 1922.

The Directors do not bind themselves to accept the lowest or any Tender.

By Order of the Board,
T. R. WYNNE, W 622
Managing Director.

STATE ELECTRICITY COMMISSION OF VICTORIA.

TENDERS FOR PLANT.

Tenders are Hereby

Invited for the SUPPLY, DELIVERY, etc., of the following for the Morwell Power Scheme.

Copies of Tender Form and Specification may be obtained or inspected upon application to:—

AGENT-GENERAL FOR VICTORIA,
Melbourne Place, Strand, London, W.C. 2.

SPECIFICATION No. 23/4—STEAM TURBINE-DRIVEN BOILER FEED PUMPS.

CHARGE:—£1 1s. for the first two copies of Tender Form, Conditions of Contract, and Specification complete. These charges will be returned on receipt of a *bona fide* Tender. A third and any further copies will be supplied for the sum of 10s. 6d. each.

PRELIMINARY DEPOSIT:—A Preliminary Deposit of £25 is required to be lodged with Tender.

The Commission does not bind itself to accept the lowest or any Tender.

Tenders on prescribed form, properly endorsed and addressed, must be delivered to the undersigned in Melbourne not later than Five p.m. on 19th January, 1923.

R. LIDDELOW,
Secretary.
State Electricity Commission of Victoria,
Melbourne, Victoria,
Australia. W 560

MIDLAND GREAT WESTERN RAILWAY OF IRELAND.

CONTRACTS FOR 1923.

The Directors of the Midland Great Western Railway of Ireland Company are prepared to receive

Tenders for the Supply of the

undermentioned STORES. The Contracts to commence from the 1st of January next, for three, six or twelve months.

	No. of Form.		No. of Form.
Asbestos & Packing	1	Oils	26
Barrows and Trucks	2	Paints, Colours and Wallpaper	27
Baskets and Mats	3	Ropes and Canvas	28
Brushes, Brooms, &c.	4	Rail Fastenings, Iron	29
Brass Fittings for Gas and Water	5	" " steel	30
Bolts, Nuts and Rivets	6	Screws, Split Pins, Nails, &c.	31
Bricks, Slates, Earthenware Pipe, &c.	7	Sheet Tin, Lead, Gun Barrel, &c.	32
Chain	8	Steel Tyres, Axles and Plates	33
Cement	9	Steel & Copper Tubes, Copper Plates and Ingots	34
Candles and Soap	10	Steel Castings	35
Carriage Fittings	11	Staffordshire Iron, Wire, &c.	36
do. Trimmings	12	Springs, Steel, and File	37
Clothing	12A	Soft Goods	38
Creosote Oil	13	Timber, &c.	39
Drysalteries	14	Tools	40
Fog Signals	15	Tool & Barrow Shafts	41
Farm Produce Boxes	15A	Varnishes	42
Glass	16	Wagon Covers and Tarpaulins	43
Grease	17	Waste and Wicking	44
Gas Mantles, &c.	18	Yorkshire Iron	45
Iron & Steel Forgings	19		
Iron Castings	20		
India Rubber Goods	21		
Lime	22		
Leather and Belting	23		
Lamps and Tinware	24		
Locks, Railwaiter Goods & Hardware	25		

Forms of Tender can be obtained, on payment of 6d. each, from the STOREKEEPER, GENERAL STORES DEPARTMENT, BROADSTONE STATION, DUBLIN. *Stamps will not be accepted.*

Patterns and Samples can be inspected at the same place on and after 1st prox., between the hours of Ten a.m. and Four p.m. (Saturdays, Ten a.m. to Twelve noon).

Contractors cannot be allowed to tender to supply goods to their own patterns, nor can the Company's patterns be sent away for inspection.

The Directors will not consider any Tender unless furnished on the Company's forms; nor any Tender in which any alteration of the form has been made.

The Tenders to be sent in by post, sealed and endorsed on the envelope, "Tender for Stores, Form No. ——," and addressed to "The Chairman, Broadstone Station, Dublin," so as to reach him on or before Ten a.m. on the 14th November.

The Directors do not bind themselves to accept the lowest or any Tender.

By Order,
PERCY A. HAY,
Secretary.
Broadstone Station, Dublin,
October, 1922. W 624

THE HIGH COMMISSIONER FOR INDIA is prepared to receive

Tenders for the Supply

of:—

1. GLAZED STONEWARE DRAINAGE PIPES, etc.
2. CAST IRON PIPES, socket and spigot, 15 in.
3. RAILWAY WHEEL TURNING LATHES, 48 in.
4. D.C. LOW TENSION THREE CORE and TWO CORE CABLES.

Forms of Tender may be obtained from the Director-General, India Store Department, Branch No. 15, Belvedere Road, Lambeth, S.E. 1, and Tenders are to be delivered at that office not later than Two o'clock p.m. on Friday, the 17th November, 1922.

T. RYAN, W 625
Director General.

CORPORATION OF DUBLIN.

The Corporation of Dublin are prepared to receive from the MANUFACTURERS OF PUMPING MACHINERY for Sewage Sludge,

Particulars, Designs, and

TENDERS for DUPLICATE ELECTRICALLY-DRIVEN UNITS, to raise about 76,000 gallons per hour of sludge through a lift of 34 ft. Plans of the existing pumping arrangements may be inspected at the City Engineer's Office, 28, Castle Street, Dublin, and at the Offices of Mr. J. S. Alford, M.Inst.C.E., 11, Victoria Street, Westminster, S.W. 1, London. Firms desirous of tendering will be supplied with a drawing shewing the existing structural arrangements, and a specification of the conditions to be complied with, upon the deposit of Two Guineas at either of the aforesaid offices. The deposit will be refunded on the return of the whole of the documents and the receipt of a *bona fide* Tender.

Tenders, sealed and endorsed on the envelope "Tender for Sludge Pumps," are to be addressed to the Chairman of the Streets Committee, 26, Castle Street, Dublin, and must be forwarded so as to reach him not later than noon on Tuesday, 21st November, 1922.

JOHN J. MURPHY,
Town Clerk.
Dublin,
13th October, 1922. W 616

TENDERS FOR THE PURCHASE OF STORES FOR POST OFFICE TELEGRAPH AND TELEPHONE SERVICES.

BY COMMAND OF THE POSTMASTER GENERAL, IRISH PROVISIONAL GOVERNMENT.

Tenders will be Received

for the following WIRE:—

Description	Quantity	Tenders Due Noon on
Copper Hard drawn Wire	90 tons ...	14th November, 1922.
Wire Bronze Wire ...	25 " ...	14th November, 1922.
Galvanised Iron Wire	70 " ...	14th November, 1922.

Forms of Tender and schedule may be obtained from the undersigned.

M. DALTON,
Controller of Stores.
Post Office Stores Department,
Aldborough House, Dublin. W 617

THE BURMA RAILWAYS COMPANY, LIMITED.

The Board of Directors of the Burma Railways Company, Limited, are prepared to receive

Tenders for the Supply

of:—

(a) 530 STEEL TYRES for Carriages and Wagons.
(b) 305 tons STEEL MATERIAL. (Channels, Angles, Flats and Rounds.)

For each copy of the Specifications (a) and (b), a fee of 1os. will be charged, which fees are not returnable. Tenders enclosed in sealed envelopes endorsed "Tender for Steel Tyres for Carriages and Wagons," or "Steel Material," must be delivered at the Company's Offices not later than Twelve Noon on Monday, 6th November, 1922. The Directors do not bind themselves to accept any or the lowest Tender, and reserve the right to divide the order.

The Tyres are urgently required in Burma, also a portion of the Steel Material.

By Order of the Board,
F. C. FRANKS,
Secretary.
199, Gresham House,
Old Broad Street,
London, E.C. 2.
27th October, 1922. W 633

ROMFORD RURAL DISTRICT COUNCIL.

RIVERSIDE SEWERAGE.
CONTRACT No. 4.
PUMPING MACHINERY, AUXILIARY PLANT, ETC.

The Council are prepared to consider

Tenders from approved

Makers of Sewage Pumping Machinery, for the CONSTRUCTION and ERECTION at their proposed Outfall Works, adjoining Rainham Creek, Parish of Hornchurch, Essex, of the PUMPING MACHINERY and other PLANT required.

The Contract includes: Centrifugal Pumps, Vertical Semi-Diesel Engines, Overhead Travelling Crane, Sludge Ejectors, Pipe Work, and all Auxiliary Plant and Accessories.

The whole will be let in one Contract, and all the principal parts must be British manufacture.

The General Conditions, Specification, and Drawings, may be inspected at the Office of the Consulting Engineer, Mr. William Fairley, M.Inst.C.E., Parliament Mansions, Westminster, S.W. 1, and a limited number of copies of the Specification are available for issue to Pump Makers direct, on deposit of crossed cheque for £5 5s. made payable to the Council, which deposit will be returned on receipt of a *bona fide* Tender.

Tenders to be lodged with the undersigned on or before Monday the 27th day of November 1922.

The Council do not bind themselves to accept the lowest or any Tender.

T. W. A. GREENHALGH,
Clerk to the Council.
10a, South Street,
Romford, Essex.
24th October 1922. W 646

THE ROYAL BOROUGH OF KENSINGTON.

PURCHASE OF ROAD ROLLER.

The Council of the above Borough are prepared to receive

Tenders for the Supply of a

TEN TON (nominal weight) COMPOUND STEAM ROAD ROLLER.

Further particulars can be obtained at the office of the Borough Engineer and Surveyor at the Town Hall, Kensington, W. 8.

Tenders, sealed and endorsed "Tender for Road Roller," must be delivered at the office of the undersigned not later than MONDAY, the 13th November, 1922.

The Council do not bind themselves to accept the lowest or any Tender.

(Signed) WM. CHAMBERS LEETE,
Town Clerk.
Town Hall, Kensington, W. 8.
24th October, 1922. W 567

ADMINISTRATIVE COUNTY OF LONDON.

SOUTH-WESTERN STORM RELIEF SEWER.

The London County Council invites

Tenders for the Construction

in Tunnel of a 7 ft. 0 in. Internal Diameter SEWER, in brick or iron, of a total length of about one mile in the Metropolitan Boroughs of Lambeth and Wandsworth.

The Specification, Form of Tender, etc., may be obtained on application to the Chief Engineer of the Council, at Old County Hall, Spring Gardens, S.W. 1, upon payment of the sum of £5. This amount will be returnable only if the tenderer shall have sent in a *bona fide* Tender and shall not have withdrawn the same. Full particulars of the work may be obtained on personal application, and the contract documents may be inspected before the payment of the fee.

No Tender received after Twelve noon on Tuesday, 14th November, 1922, will be considered. The Council does not bind itself to accept the lowest or any Tender.

JAMES BIRD, W 653
Clerk of the London County Council.

THE GREAT INDIAN PENINSULA RAILWAY COMPANY.

The Directors are prepared to receive

Tenders for the Supply of the

following STORES, namely:—

No.		Fee for Specification.
1.	Galvanised Stamped Steel Mortar Pans	5s.
2.	Carriage Door Handles, Hinges, etc.	10s.
3.	Sleeves, etc.	7s. 6d.
4	Lamp Glasses, etc.	2s. 6d.

Specifications and Forms of Tender may be obtained at this office on payment of the fee for the Specification, which payment will not be returned.

The fee should accompany any application by post. Cheques and Postal Orders should be crossed and made payable to the Great Indian Peninsula Railway Company.

Tenders must be delivered in separate envelopes, sealed and addressed to the undersigned, marked "Tender for Galvanised Stamped Steel Mortar Pans," or, as the case may be, not later than Eleven o'clock a.m., on Tuesday, the 7th November, 1922.

The Directors do not bind themselves to accept the lowest or any Tender.

R. H. WALPOLE,
Secretary.
Company's Offices,
48, Copthall Avenue, E.C. 2.
London, 25th October, 1922. W 669

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ARMSTRONG COLLEGE, NEWCASTLE-UPON-TYNE.

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Last date for application, 30th October.

Further particulars may be had on application to the REGISTRAR, Armstrong College. W 561

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A Vacancy exists for an

ENGINEER, Grade I, in H.M. Signal School, R.N. Barracks, Portsmouth. Applicants must have had a sound training in Electrical Engineering, both theoretical and practical, and experience of the manufacture or use of Wireless Telegraphy apparatus.

The work will consist in dealing with technical correspondence, writing technical specifications, etc. for Wireless Telegraphy and similar apparatus; also in examining apparatus to ensure that it meets specified requirements.

The salary scale is £300–£15–£360, plus Civil Service Bonus (at present rates this makes the commencing Salary approximately £449 per annum). The position also carries with it certain rights under a superannuation scheme.

Applications should be forwarded as soon as possible to the SECRETARY, Civil Establishments Branch, Admiralty, London, S.W. 1. W 621

Traveller. — Iron Tubes and

FITTINGS in LONDON.—REQUIRED, the SERVICES of an EXPERIENCED MAN with good connection, permanency and good prospects. —Write, in strict confidence, stating experience, age and salary required to COSMOS, c/o Deacon's, Leadenhall Street, E.C. W 630

Required, Competent Inspector

for Structural Steelwork in London District.—Address, giving testimonials, age, record and salary required, W 643, Offices of Engineering.

Works Manager Wanted by

well-known Light Car Manufacturers, must have extensive works experience and knowledge of motor car design. Good position for first-class man, state fully qualifications, experience, etc.; discretions guaranteed.—Write BOX A, W. H. Smith & Son, 11, Kingsway, W.C. W 637

EPICYCLIC GEARS: THE GEAR RATIO DIAGRAM.

By P. CORMACK, A.R.C.Sc.I.

1. *Introductory.*—Few engineers can figure out the speed ratios of an epicyclic gear set with the same ease and confidence with which they attack the corresponding problem in ordinary spur gearing. The transformation from the latter to the more general epicyclic type can, however, be made with but little labour by the use of the gear ratio diagram which is here developed. The introduction of this diagram will be found to give complete generality in the solution of problems on wheel trains, and to bring under intuition the properties of trains when used epicyclically. This latter feature will be found specially helpful in the design of epicyclic gears.

The applicability of the diagram extends also to rotational accelerations.

2. *Gear Ratio Diagram.*—If the segments $p\,a$, $p\,b$, $p\,c$, . . ., $p\,q$ of a line, Fig. 1, be proportional to the speeds of the wheels A, B, C, . . ., Q, of a

Fig. 1. GEAR RATIO DIAGRAM

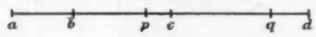
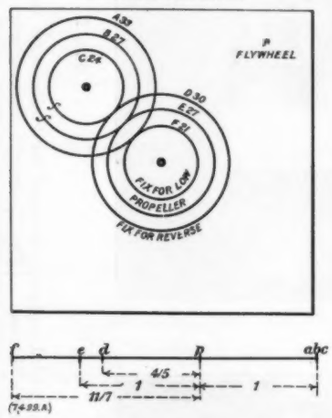


Fig. 2. FORD EPICYCLIC GEAR AND GEAR RATIO DIAGRAM.



wheel train when P is fixed, then the segments $q\,a$, $q\,b$, $q\,c$, . . ., $q\,p$, are proportional to the speeds of the wheels A, B, C, . . ., P, when Q is fixed. A formal proof of this proposition may be obtained by considering the fixing of Q as being due to the imparting to the whole train of a motion equal and opposite to that possessed by Q. Thus, let a rotation $q\,p$ be added to the rotations $p\,a$, $p\,b$, $p\,c$, . . ., $p\,q$, o, of A, B, C, . . ., Q, and P. The resultants are:—

Rotation of A = $q\,p + p\,a = q\,a$
" B = $q\,p + p\,b = q\,b$
" C = $q\,p + p\,c = q\,c$
" Q = $q\,p + p\,q = o$
" P = $q\,p + o = q\,p$

Hence the proof.

3. *Application to Epicyclic Gear Set.*—As an example, we show how the gear ratios of the Ford motor car transmission gear are exhibited by the diagram. This gear is shown in Fig. 2. The engine flywheel P carries the axle of the planet group A B C. B meshes with E, the propeller shaft; A meshes with F, which is fixed for the slow speed; and C meshes with D, which is fixed for the reverse. Taking P to be fixed, if A make one turn, so will B and C, since they are keyed to A. One turn of A gives $-33/21$ turns of F; one turn of B gives -1 turn of E; one turn of C gives $-24/30$ turns of D. To construct the gear ratio diagram, we therefore draw $p\,a = p\,b = p\,c = 1$; $p\,f = -33/21$ or $-11/7$; $p\,e = -1$; $p\,d = -24/30$ or $-4/5$. We can now read off the low gear ratio of the propeller E to the flywheel P, when F is fixed. It is $f\,e/f\,p$. Since $f\,e = 11/7 - 1 = 4/7$, and $f\,p = 11/7$, the low gear ratio $f\,e/f\,p$ becomes 4/11.

With D fixed, as it is for the reverse gear, we have the speeds of the flywheel P and the propeller shaft E proportional to $d\,p$ and $d\,e$. The lines $d\,e$ and $d\,p$ being in opposite directions show that E and P revolve in opposite senses. Numerically $d\,e = 1 - 4/5$ or $1/5$, while $d\,p = 4/5$. The reverse gear ratio $d\,e/d\,p$ is therefore 1/4.

4. *Compound Epicyclic Gear.*—The wheel arrangement of the Lanchester epicyclic gear is shown in Fig. 3. The four toothed wheels A, B, C, D, have 28, 80, 80, and 28 teeth respectively. C carries the axle of a planet wheel which meshes with A and B, while B carries the axle of a planet wheel which meshes with C and D. [Actually the planet carried by B meshes externally with D and internally with C.] The wheel A is connected to the crankshaft and C to the propeller shaft.

To construct the gear ratio diagram, we assume C to be fixed and note that for one turn of B, A makes $-80/28$ turns. From c we therefore set out $c\,b = 1$ and $c\,a = -80/28$. Next assume B fixed and note that for -1 revolution of C we get 80/28 revolutions of D. As we have $b\,c = -1$ already on the diagram, we have but to draw $b\,d = 80/28$ to

Fig. 3. LANCHESTER COMPOUND EPICYCLIC GEAR (SCHEMATIC) WITH GEAR RATIO DIAGRAM.

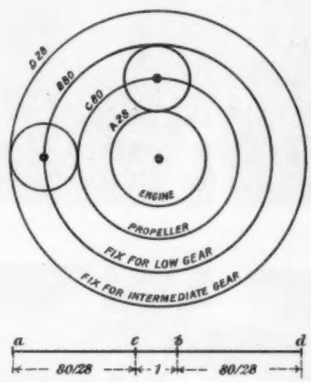
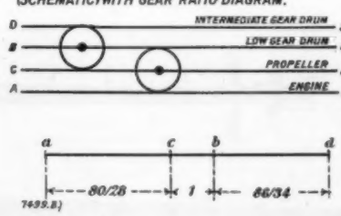


Fig. 4. LANCHESTER COMPOUND EPICYCLIC GEAR (SCHEMATIC) WITH GEAR RATIO DIAGRAM.



complete it. The low gear ratio of the propeller C to the engine A, obtained by fixing B, is $b\,c/b\,a = 1 \div 108/28$ or 0·259. The intermediate gear ratio is obtained by fixing D, and is therefore $d\,c/d\,a = \frac{108}{28}/\frac{188}{28}$ or 0·575.

A second example in which no two wheels have the same number of teeth is shown in Fig. 4. Here the mechanism diagram is simplified, and may be read either as giving a development of the rims A, B, C, D, as shown in Fig. 3, or as giving an edge view of these wheels.

As before, if C is fixed, B makes 1 turn while A makes $-80/28$ turns. These revolutions are represented by $c\,b$ and $c\,a$ on the gear ratio diagram. Again if B be fixed, C makes -1 revolution while D makes 86/34 revolutions. These rotations are represented by $b\,c$ and $b\,d$ on the diagram. The low gear ratio of C to A, obtained by fixing B, is $b\,c/b\,a = 1/\frac{108}{28}$ or 0·259 The intermediate gear ratio obtained by fixing D is $d\,c/d\,a = 21/38$ or 0·552.

5. *Angular Acceleration.*—Corresponding to the proposition of Art. 2 for rotational velocities, we have the analogous proposition for rotational accelerations, a statement and proof of which is given in Art. 2, if "angular acceleration" be written for the words "speed," "rotation," and "motion" occurring therein.

LOCOMOTIVE COAL AND ASH-HANDLING PLANT AT CREWE.

WE have frequently pointed out that post-war conditions render necessary the substitution of mechanical handling devices for manual labour, wherever practicable, and have often noticed the difference between American methods of dealing with locomotive coal, and those common in this country. In the North American Continent with labour relatively scarce, and its cost high, it became the practice many years ago to deal with locomotive coal by mechanical means at depots of any size, and the capital invested in such plant was generally justified. On the other hand in England at that time labour costs were low, and the saving by capital expenditure on labour-saving plant could often be shown without difficulty to be non-existent. With present conditions here, the position is altogether changed, and it is now imperative to seek economy by the reduction of labour, and many of the larger locomotive centres in this country would probably be found amenable to treatment with this object.

It will probably be remembered that the London and North-Western Railway some years ago introduced a bucket conveyor type of locomotive coal-handling plant, a paper being read on the subject by the late Mr. C. J. Bowen Cooke before the Institution of Civil Engineers in 1912 (see Proc. Inst. C.E., vol. cxci, page 178). A greatly improved type of plant was put into use some time ago, designed and constructed by the Mitchell Conveyor and Transporter Company, Limited, Atlantic House, Holborn Viaduct, E.C. 1. This plant, embodying various features protected by patents we illustrate in Plate XXXV with this week's issue of ENGINEERING, and on pages 512 to 514 and 526. General elevations and a plan of the plant are given in Figs. 3, 4 and 5, Plate XXXV, while the view Fig. 1, on page 512, shows the general appearance of the installation. A key plan is shown in Fig. 6, Plate XXXV.

The plant consists of a reinforced concrete bunker raised a sufficient height above the rail level for the coal to be fed to the locomotives by gravity, and the gear provided for dumping the coal into the bunker or hopper. The dumping gear consists of a cradle capable of accommodating a coal wagon which is hoisted inside a tower, and provision for overturning the cradle and wagon at the requisite height for the coal to be deposited in the hopper. The cradle is raised by ropes wound over drums housed at the top of the structure (Figs. 3 and 4, Plate XXXV).

Before passing to a description of the mechanical features of the plant we may briefly deal with the reinforced concrete bunker which was constructed to the designs of Messrs. L. G. Mouchel and Partners, 36, Victoria-street, Westminster. This bunker is designed for a capacity of 250 tons, and it is provided with six discharge openings serving two roads. The general arrangement of this part of the structure will be clear from Figs. 19 to 24, on page 513, from which it will be seen that the bunker stands on eight 14-in. by 14-in. columns resting on concrete footings, 5 ft. and 6 ft. 6 in. square. The footings are about 2 ft. below rail level, and the load distribution is calculated at $1\frac{1}{2}$ tons per square foot. The walls of the bunker having to withstand the pressure of the coal, have a thickness of $5\frac{1}{2}$ in., and are strengthened by counterforts to take the main stresses and loads. The back wall is designed to carry the steel structure of the hoist in addition to the loads imposed by the coal stored. Reinforced concrete slab foundations are provided for the lattice columns of the tippler, and these are tied into the tippler cradle pit. The latter is integral with the column foundations on the bunker side, thus forming one base and tieing the whole well together at this level. The underside of the foundations, and of the cradle pit are all at the same level. The bunker has a length inside of 34 ft. and a width of 19 ft. 6 in. The bottom is 8 in. thick and is supported by a longitudinal and two cross-beams, from which it is suspended. The height is 38 ft. 9 in. above the rail level, and at the top an opening 34 ft. long and 10 ft. wide is provided, through which the coal is tipped into the bunker. A

LOCOMOTIVE COALING PLANT AT CREWE; LONDON AND NORTH-WESTERN RAILWAY.

CONSTRUCTED BY THE MITCHELL CONVEYOR AND TRANSPORTER COMPANY, LIMITED, ENGINEERS, LONDON.

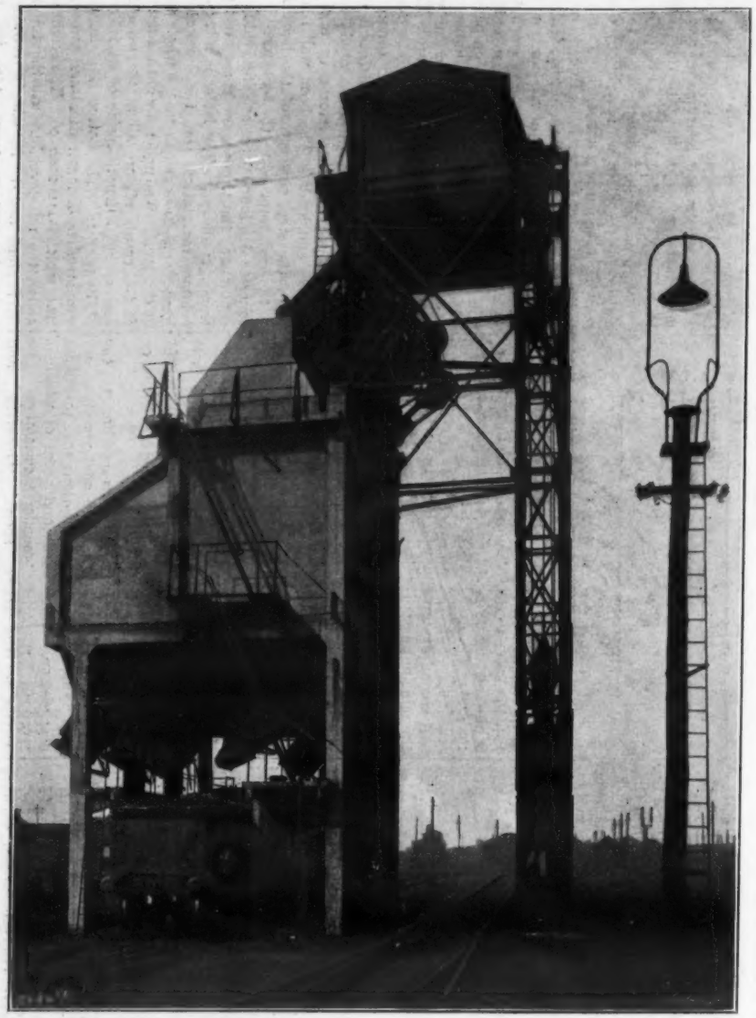


Fig. 1. General View of the Coaling Plant.

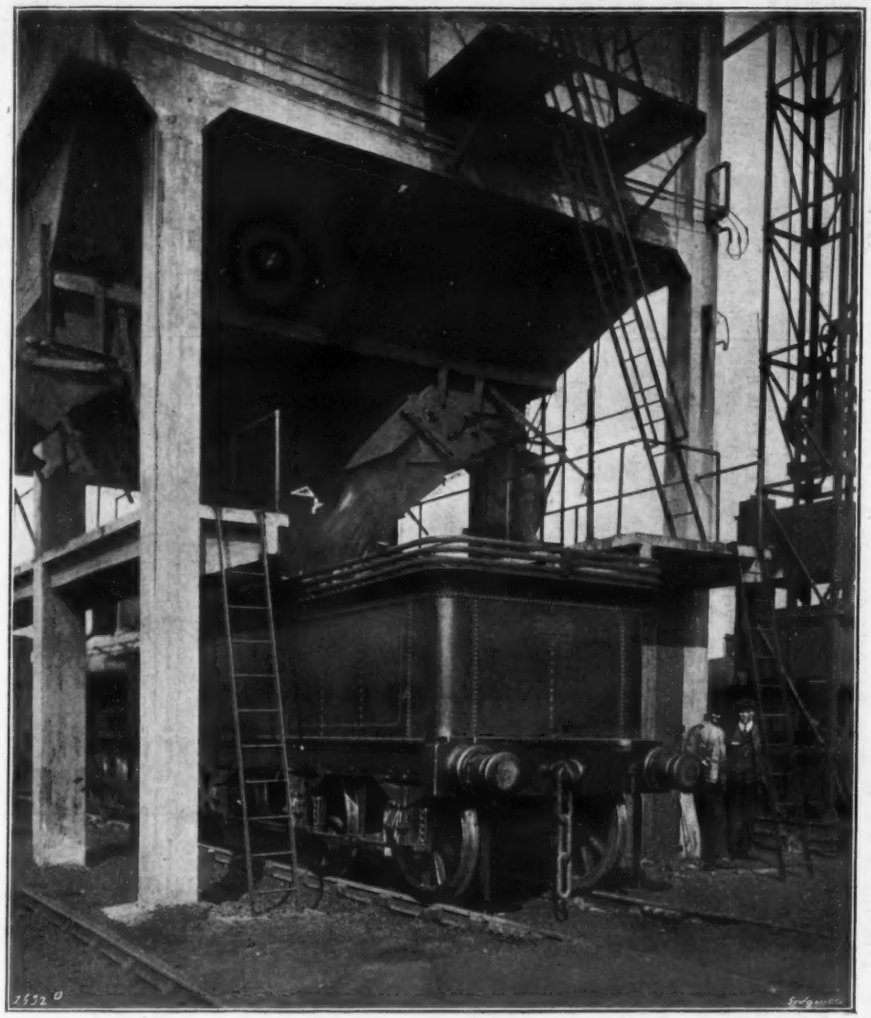


Fig. 2. Tender Locomotive being Coaled.

reinforced concrete wind screen has been constructed round three sides of this opening to protect the coal. It may be mentioned here that the weight of the bunker is about 160 tons, of the tippler foundations 10 tons. The tower complete with all gear, balance, &c., weighs about 38 tons, and the loaded wagons handled together with the cradle weigh 24 tons.

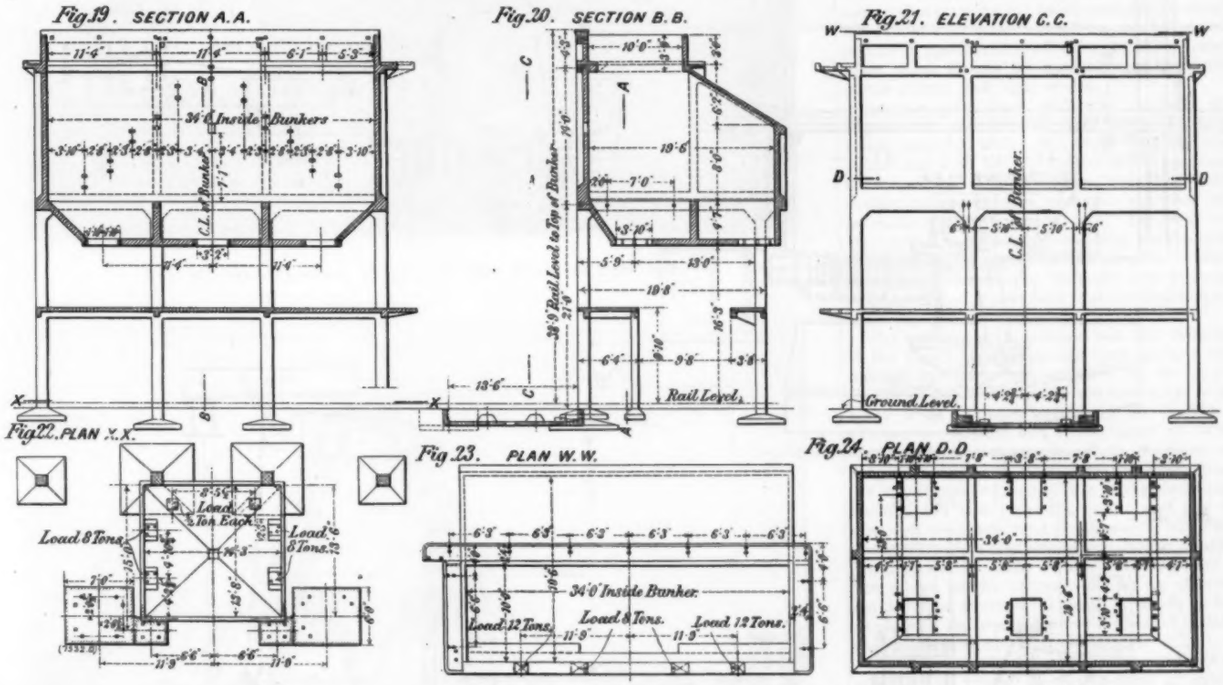
The six discharge points as mentioned serve two roads. Each is fitted with an under-valve, calibrating chamber and chute. A special extension is arranged for loading tank engines. The view, Fig. 2, shows a tender engine at the plant, in process of being coaled, while Fig. 40, page 526, shows the extension used in coaling tank engines. This and the valves, &c., are worked by hand from reinforced concrete platforms at a level of 9 ft. 10 in. above the rail level.

The wagon hoist and tippler is arranged to handle any size of wagon up to 12 tons capacity, and in height ranging from 6 ft. to 9 ft. As already stated

the wagons are raised from rail level to the top of the bunker, into which the contents are tipped. The hoist consists of a cradle, which in its lowest position (Figs. 3 and 4) stands on blocks in the concrete pit already mentioned. The cradle is fitted with automatic chocks for supporting the side of the wagon, and automatic stops and hooks which come into action as soon as the cradle is raised. In its lowest position the coal wagons can be run straight on to the cradle from the elevator road (Fig. 6). The cradle itself is illustrated in Figs. 7 to 13. It is built up of structural sections and steel plate. Fig. 7 shows an end elevation; Fig. 10 two half-views at the lines A–B and C–D in Fig. 7, and Fig. 11 two half plans. The cradle is hoisted by two steel wire ropes which pass from the winding drums in the winch-house overhead, over guide pulleys and then down to and round the underside of the cradle, and up to a point near the top of the bunker where the ends are fastened. The ropes are carried round the cradle the whole to turn on these rollers, into the tipping position shown in Fig. 4. Before dealing with the further motions after this point, it will be convenient to return to the cradle gear.

The cradle is fitted with three automatic movements of some interest. The first of these is the automatic chock which comes into action as soon as the cradle is raised off the ground, and gives support to the side of the wagon. The second relates to the scotch blocks provided to prevent the wagon running off the cradle, and the third, to safety hooks which are provided for additional security against such movement. The automatic chock is shown clearly in position in Fig. 39, page 526, while Figs. 14 to 16, Plate XXXV, show the construction of the beam itself. The beam is faced with timber covered with hemp rope, and provides support for the wagon during tipping. As soon as the cradle commences to rise the chock advances and presses against the side of the wagon, in which position it locks itself. The operating gear fixed fixed quadrant and becomes locked, holding the chock in position. On descending, the operating rod strikes the stop and the quadrant is unlocked, and the chock is moved clear by the upward movement of the rod, causing the crank to strike a stop on the quadrant.

The scotch block gear is illustrated in Figs. 25 to 31, of which the first three show the arrangement on the cradle, and the remainder details of the parts. Each block is fixed on a lever pivoted at the side of the rail (Fig. 27). The upper arm is drawn in towards the rail by means of a pull rod and horizontal helical spring, of which the pressure can be adjusted. When the lower end of the cranked lever is free, the spring pulls the scotch across the rails. This is the normal condition where the cradle is off the ground. When the cradle approaches the ground, as it comes to rest upon its blocks, the roller on the lower end of the cranked lever comes in contact with a stop. Further downward movement then causes this lever to withdraw the scotch, and the latter is held clear



over pulleys and guides. Referring to Fig. 7, a guide pulley will be noticed (shown dotted) at the left hand upper corner. The rope passes first over this as will be clear on reference to Fig. 4. It then passes through the forked end of a fixed guide, shown in detail in Fig. 9. From here it passes over a larger diameter pulley shown at the lower left-hand corner, from which it is passed between a pair of guides, one of which is shown in Fig. 12.

Across the underside of the cradle the rope is passed over another large pulley and then off to the fixed structure above. This arrangement of slinging the cradle will be followed in Figs. 3 and 4, while the view Fig. 39, page 526, gives an excellent idea of the whole, with a wagon in position and the hoisting operation just commenced.

The cradle is fitted on one side with two sets of small rollers (shown on the right of Fig. 7). These work in long vertical guides consisting of steel channels, and extending upwards to the point at which the wagon is tipped. When the cradle has reached the proper height for tipping, the upper pair of small rollers is guided in a curved path, while the lower pair is released from the vertical channels. Further movement, as the rope continues to be hauled in, then causes the cradle to tilt until the cradle forks shown at the right hand top corner of Fig. 7, and in Fig. 13, come into contact with two rollers mounted on the back wall of the bunker. The continuation of the hoisting motion causes to the cradle uprights is shown in Figs. 32 and 33, page 514. The chock is carried at either end by a pair of links, coupled to the same pin on the chock. In one case the other end of the link is pivoted on the cradle framing, while the end of the other link is pivoted on a toothed quadrant. The latter is free to revolve, and is also arranged to engage with a fixed toothed quadrant on the cradle. From the revolving quadrant a long operating rod hangs down, ending with a small roller. This rod is kept in position by a link working from a pin on the cradle, and an adjustable tension spring, fitted to this link always tends to pull the operating rod down. The roller of the operating rod comes in contact with a stop when the cradle is home, fully lowered out, and this holds it up. As soon as the cradle rises, the rod is pulled down by the spring. This movement results in freeing the revolving quadrant, and the chock falls forward against the side of the wagon. The spindle to which the crank worked by the operating rod is keyed, and on which the quadrant revolves, is hollow and fitted with an helical slot in which a block works. The latter is fixed to the quadrant, and when the chock has come up against the wagon side and the outward movement is stopped, further movement of the operating rod as a result of the continued movement upwards of the cradle, causes the block to slide in the helical slot just mentioned. This moves the toothed quadrant to one side, so that it engages with the until the cradle is again raised after loading with a fresh wagon.

The safety hooks intended to give additional security are illustrated in Figs. 17 and 18, Plate XXXV. These safety hooks consist of bent levers which rise, as soon as the cradle is lifted, to such a height that the hooked end of each is on a level with the wagon axle, as shown in Fig. 17. The lever hooks are pivoted on the cradle, and their upward movement is assured by compression springs fixed at the lower extremity. In descending, the lower end of these levers come in contact with a stool, and further movement compresses the springs and lowers the levers, so that when the cradle rests on its blocks the hooks are forced back into the position shown in dotted lines in Fig. 17, where they lie between guards. The view given in Fig. 39 shows the cradle before these further safeguards were fitted.

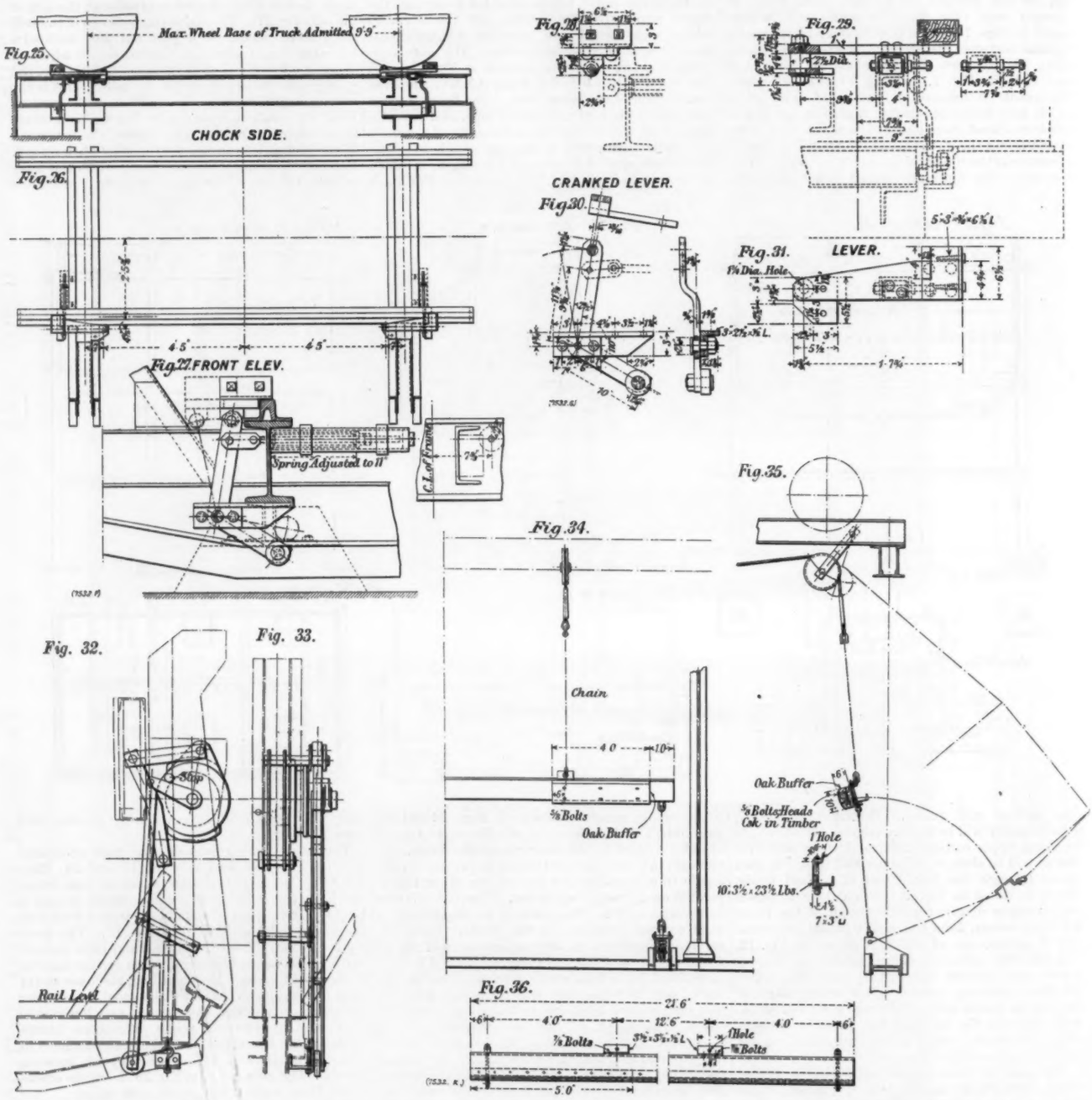
Having now dealt with the means of holding the wagon on the cradle during hoisting we will proceed to describe the manner in which it is controlled during tipping. Above the bunker, across the opening through which the wagon is tipped, is suspended a stout horizontal sustaining beam. This is hung by two chains attached to wire ropes, as shown in Figs. 34 and 35. Fig. 36 shows the beam, to the face of which a pair of oak buffers is fastened. The suspension ropes are passed over pulleys at the top of the tower and are carried over other pulleys from which they hang down, having attached to

the lower end balance weights working in vertical lattice frames. The sustaining beam moves at a fixed radius (save for a small shock absorber movement) round the point on which the wagon pivots in tipping, and as this movement proceeds the suspension ropes are automatically paid out as necessary. The sustaining beam gear is sufficiently balanced to hold the wagon in the tipping position, and to restore it with the cradle to the vertical as soon as the hoisting ropes are paid out for this movement. The arrangement is fully automatic, and does no damage to the wagons. A further advantage that it presents over the usual methods of clamping is that it leaves the wagon free as soon as tipping is completed. The common system of clamping occupies time and labour both before lifting, and after lowering out. The Mitchell sustaining beam system eliminates both these, rendering operation much more rapid. A further advantage is that the beam presents a minimum of obstruction to the coal in tipping.

On returning to the vertical the lower cradle rollers are caught in forks which lead them into the vertical channel guides for lowering out. The hoisting is performed by two winches driven by a single 25-b.h.p. electric motor. A view of the winch room is given in Fig. 41, page 526. The hoisting ropes, after being led round the winding drums are passed over pulleys, and are finally attached to heavy balance weights suspended by sheaves and hung in the tower legs. The cradle and wagon and part of the coal are balanced, and the motor has therefore only to deal with about half the load of the coal. A relatively small consumption of power is thus secured. The power taken per ton of coal handled amounts to 0·1 B.Th.U.

It is found in operation that a complete cycle can be performed in 3 minutes. This time is occupied approximately as follows: hoisting, 62 seconds; tipping, 28 seconds; reversing, 28; lowering out, 62. Allowing two minutes for running the wagon on and off the cradle the whole round is completed in about 5 minutes, or at the rate of 12 wagons per hour. The whole of the hoisting and tipping is automatic. The hoist is operated by one man by means of a tramway type controller, and all the necessary limit switches are fitted to prevent excessive movement. The actual coaling of the engines is attended to by a second man. Engines can be coaled at this plant if necessary at the rate of from 50 to 60 per hour. The day hoist-man can stock sufficient coal in the bunker to last through the night, during which time only the man doing the actual coaling has to be in attendance.

Situated not far from the coaling plant at Crewe is an ash-handling plant also by the Mitchell



Conveyor and Transporter Company, Limited, and one of several supplied by them recently to the London and North-Western Railway. The plant is illustrated in Figs. 37 and 38, subjoined, from which the skip is hoisted and tipped. A limit switch brings the skip to rest, after which the reversing of the controller lowers the skip again to the bottom, where again a limit switch arrests the movement

FIG. 37. ASH-HANDLING PLANT; COALING PLANT IN DISTANCE.

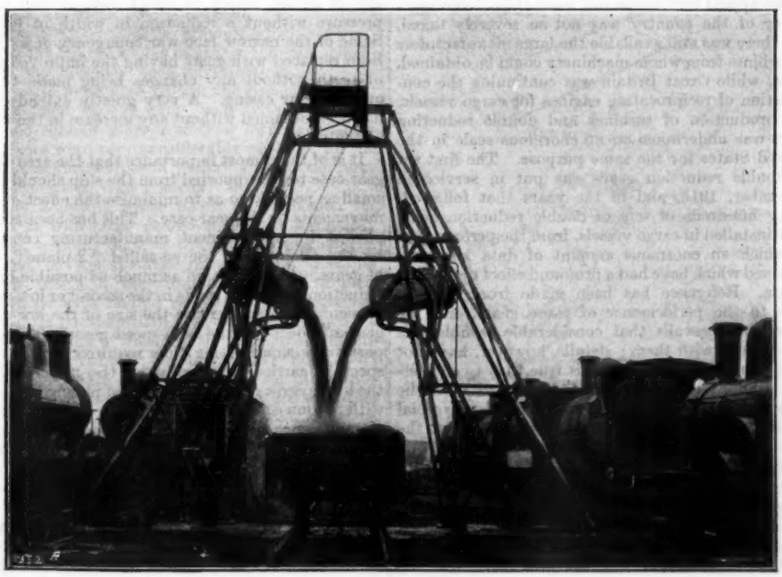


FIG. 38. SKIPS DISCHARGING ASHES.

its action will be sufficiently clear with but a brief description. The plant consists of two independent ash-hoists, each embodying an electrically operated skip worked from an underground pit by rope. The skips are furnished with small rollers which run on guides so shaped that when a certain stage in the lift has been reached the front wheels of the skip run forward while the rear portion continues to be lifted as shown in our illustrations, with the result that the contents are tipped. Each skip hoists about ½ ton of ashes a vertical distance of 22 ft. from a pit below the engine road, and dumps it into a wagon standing on a track spanned by the hoist structure. The locomotive ashes are dumped direct from the engine into a hopper in the track, and through this into the skip below. The operator moves a control handle to the forward notches and at the correct point. The time taken to hoist is about 50 seconds and to lower out, the same.

POINTS OF LAW IN ENGINEERS' CONTRACTS.

AT a general meeting on Tuesday, the 10th inst., of the Institution of Heating and Ventilating Engineers, Mr. Robert Fortune, barrister-at-law, read a paper on some points in the law of engineers and architects' contracts. The paper purported to be limited to the law of heating engineers' contracts, but its scope was wider than its title. Mr. Fortune referred to the class of building contract in which the building owner reserves power to select specialists to do certain parts of the work. In such cases it is sometimes difficult to know whether the specialist is employed as a sub-contractor or has contracted directly with the building owner, and Mr. Fortune advised that engineers and architects should be clear in their own minds as to the business relationship of the parties and should see that it is made clear in his dealings with them. He referred also to the vexed question of "extras," and advised that engineers ordering extras or deviations from contracts should see that they have express authority from the building owner to order them. The mere fact that work is indispensable to complete a contract does not necessarily give the engineer authority to order it, and an engineer exceeding his authority is liable to be sued by the contractor for what he has lost by relying upon the engineer's supposed authority.

On the general duties of the engineer, Mr. Fortune says he must take reasonable steps to examine the site, ascertain and comply with all general Acts of Parliament and all bye-laws and regulations lawfully made which relate to the site in question and to work of the class which he undertakes to plan and see executed, and he must see that any necessary approval of plans by any public authority is obtained. He should also make himself acquainted with any private or special rights affecting the site in question, upon which it may be desirable that the building owner should seek legal advice.

Another point dealt with was the right of the engineer to payment for plans when the building is not proceeded with. In a Scottish case a building owner was sued for the cost of the preparation of certain plans. The defence was that they were got merely on approbation, and that payment was to be made only if they were used. It was true that they had not been used for building, but the building owner had used them for the purpose of shewing intending purchasers of the land how it could be developed, and it was held that the building owner must pay the architect.

The use of new inventions was also referred to. If the building owner insists upon using a new or untried invention, the engineer or the architect should make it clear that he will not accept responsibility if it is unsuccessful. In an English case (Turner *v.* Garland and Christopher) an architect was employed to prepare plans of some model lodging houses and to superintend their erection. He was instructed to put in a new patent concrete roofing, but this proved a failure and had to be removed. He was sued for damages, but Erle, J., charged the jury that although failure in an ordinary building was evidence of want of competent skill, yet if out of the ordinary course an architect is employed in some novel thing in which he has no experience and which has not the test of experience, failure may be consistent with skill.

Mr. Fortune also referred to the engineer's duties when he is placed in the position of arbitrator between the contractor and the building owner. Consideration of the cases, he says, shows how important it is that the engineer should keep clearly in his mind in what capacity he is acting, and should realise that while he is merely acting as the agent of the building owner his duty is to him as his employer, but in so far as he is called upon to act between the building owner and the contractor his duty is that of a quasi-arbitrator, and he must hold the scales impartially. If he does so, the court will not question his discretion and judgment; but if he allows himself to be swayed from this course, however honestly, by pressure of any sort, the court will not uphold his authority. This is indeed a thorny subject. Contractors generally consider it a serious grievance that the resident engineer on a job is usually made the sole arbitrator in cases of dispute between the contractor and the building owner. It would be much better if public authorities and other bodies who give out work to be done on contract were willing to have disputes arbitrated upon by arbitrators who were entirely neutral and not associated with either of the parties.

EXPORT OF GERMAN CEMENT TO HOLLAND.—The Commercial Secretary, Occupied Territory, Cologne, has forwarded to the Board of Trade an extract from the *Kölnische Zeitung* which states that the German Cement Syndicate has, with effect from October 1, reduced the price for deliveries of cement to Holland by 1·50 fl. for the southern districts and by 4 fl. for the Netherland oversea districts in order to meet British competition.

DOUBLE-REDUCTION GEARS FOR MARINE USE: UNITED STATES PRACTICE.

By J. Livingston Booth.

The marine engineering industry is in a somewhat disturbed condition, not only due to the depression through which it has been passing, but also from some lack of confidence in some of the more recently developed propulsion machinery. At a recent conference of ship owners and manufacturers there was a noticeable absence of the confidence in double reduction gears which had characterised earlier conferences, and there is undoubtedly a feeling in marine circles that this form of propulsion should be abandoned.

All engineers will probably agree that as long as shipowners adhere to steam rather than Diesel engines, the prime mover, so far as we can see at present, will be the turbine, and that it would be a backward step in engineering both as regards economy, weight, and space occupied, to advocate a general return to steam reciprocating engines. This being so, the next logical step in the application of the turbine to marine use is the development of the high-speed turbine, which though it necessitates some form of speed reduction between the turbine and the propeller in order to secure the best efficiency of the latter, gives a further economy of fuel, weight and space, compared with the direct-connected turbine installation.

In the selection of the means of speed reduction between the turbine and propeller, there are to-day practically only two alternatives which have been tried on a sufficiently extensive scale to judge of their merits, viz., mechanical gearing and electric drive. It would seem as if we are about to enter upon an engineering controversy regarding their respective merits similar to the battle of the boilers which raged about twenty years ago.

It is undoubtedly true that some shipowners are finding themselves in an embarrassing situation from the fact that geared ships which were ordered on quite an extensive scale some time ago are not coming up to expectations in their performance. In other cases owners who held up construction during the time of highest prices, have since had experience or obtained information which has made them distrustful of the double reduction gears with which they originally intended to equip their ships, and the construction of the hulls is too far advanced to provide, at least without much structural alteration and expense, the larger engine-room required for reciprocating engines. This has resulted in a considerable amount of additional interest being shown in electric drive as a solution of the difficulty.

Electric drive has, of course, passed far beyond the experimental stage, particularly in the United States. There it has been the standard type of propulsion machinery for capital ships of the United States Navy for some years and a number of both naval vessels and merchant ships are now in service. Orders have also been placed recently in Great Britain for some electrically-driven vessels following the successful performance of one completed last year.

On naval vessels, electric drive offers some particular advantages; and on certain types and sizes of passenger vessels, express freighters on certain runs, and some other special applications, there are strong arguments for its adoption. Apart from the saving in fuel which can be accomplished by its use in services on which the vessel is running at fractional powers for a considerable part of the time, it also possesses exceptionally good manœuvring qualities, and full astern power, which are of special value in some services. Against these advantages must be placed the fact that the average marine engineer knows little of the types of electric machinery used, and that some educational work would have to be undertaken before sufficient confidence could be felt that delays or breakdowns would not occur, due to a lack of understanding of the machinery. This objection, however, would be considerably less when employment is stable and constant changes of engineers are not taking place.

On the average cargo vessel, however, carrying from 10,000 tons to 12,000 tons deadweight, with 2,500 s.h.p. to 3,000 s.h.p., and running at approximately a constant speed, no advantage in fuel consumption can be shown, and it is difficult to justify the additional first cost and added complications of the electric machinery. In fact, if the performance of the two types of machinery be compared in this class of service it will be found that the turbine and reduction gears have slightly the better economy as well as less weight, and occupy less space. This would also hold good on twin-screw vessels of higher power where two such units would be used. This is due not only to the rather better overall economy of the geared turbine, but also to the fact that the quantity of auxiliary exhaust steam available will permit a better heat balance in the engine-room.

There is a danger, therefore, in the desire to overcome the present difficulties of repeating the mistakes which were made by the wholesale adoption of gearing at a time when there was an insufficient knowledge of the art, if other types of machinery are adopted to the exclusion of gears without a proper consideration being given to the advantages and possibilities of each in their own special field of application. It is well, therefore, to review what has been done up to the present time in the development of double reduction gears, as, if satisfactory gears can be built, they offer at present the greatest improvement over reciprocating engines.

When the programme of cargo vessels to replace the losses of the submarine campaign was undertaken in Great Britain, most of the manufacturers of marine machinery were already taxed to their utmost capacity with work for the Navy, and reciprocating engines were standardised and, in a large measure, the operations in their manufacture were performed by women.

In the United States when the enormous programme of cargo vessels was laid down in response to the appeal for "ships and more ships," the manpower of the country was not so severely taxed, and there was still available the large manufacturers of turbines from whom machinery could be obtained. Thus, while Great Britain was continuing the construction of reciprocating engines for cargo vessels, the production of turbines and double reduction gears was undertaken on an enormous scale in the United States for the same purpose. The first set of double reduction gears was put in service in December, 1915, and in the years that followed, many hundreds of sets of double reduction gears were installed in cargo vessels, from the performance of which an enormous amount of data has been obtained which have had a profound effect upon their design. Reference has been made from time to time to the performance of these gears, and the impression prevails that considerable trouble was experienced with them; details, however, have not been published hitherto. It is true that a considerable amount of trouble was experienced with the early gears, but this arose in most cases from special conditions and does not in any way show that the principal is fundamentally unsound.

The design of these early gears was very largely dictated by the exigencies of the moment. In many cases their design was influenced to a great extent by the size and quantity of the gear-cutting tools which could be obtained by the gear manufacturers at short notice. The width of gear faces were cut down to a minimum to reduce the amount of machining necessary, until the tooth pressures reached limits which are now considerad altogether too high for long life, and a great deal was sacrificed to what was considered the all-important factor at the time, namely, speed of production. One of the prominent manufacturers alone, produced over 100 sets of these early war emergency years before the production schedule laid down by the Government permitted the adoption of a more conservative design. When it is appreciated, however, that this same manufacturer was turning out propulsion machinery for an 8,000 deadweight ton cargo vessel at the rate of one complete set per day, it must be conceded that if quantity was considered at the time to be of greater importance than quality, that object was admirably obtained. These gears only had a life of a few years, sufficient to meet the war emergency, and for the most part they can be said to have done as much as could be expected from them. In many cases, however, their normal life was greatly shortened by extraneous conditions, such as inadequate foundations which permitted distortion and misalignment of the gear-case by the "working" of the ship, improper methods of installation, inadequate lubricating systems, inexperienced operators, and, in fact, a general lack of knowledge of the conditions which were essential to success. To overcome these difficulties, the principal manufacturers instituted their own systems of survey and inspection to protect the national and their own interests by keeping the ships running, and to prevent interruptions in service occurring from machinery troubles. These survey systems accomplished other important results in that they permitted an enormous amount of data to be collected by the manufacturers on the performance of the different types of machinery under actual service conditions. These data influenced subsequent design to a very great extent, and certain features and characteristics obtained from the experience of the largest manufacturer are now generally recognised as essential to success. The principal points may be summarised as follows:—

Tooth pressures should be very much less than were used on the earlier gears, say in the neighbourhood of 300 lb. per lineal inch of tooth on the high-speed and 600 lb. on the low. The reduction of tooth pressure by an increase in the width of gears is not alone sufficient to insure freedom from trouble. Increasing the distance between bearings introduces other factors of pinion deflection which must be taken into consideration, and it is possible to widen the gears to an extent that is detrimental rather than beneficial.

Greatly improved results have been obtained by a study of the meshing characteristics of different forms of teeth. It is possible to modify the form of tooth so as to increase the number of teeth in the arc of action which in effect reduces the tooth pressure without a reduction in width of helices. Some of the narrow face war emergency gears have been replaced with gears having the improved form of teeth without any changes being made to the original gear casing. A very greatly extended life has been obtained without any increase in the width of the gears.

It is of the utmost importance that the area of the gear-case to be supported from the ship should be as small as possible so as to minimise the effect of hull movements on the gear-case. This has been accomplished by a prominent manufacturing company by the adoption of the so-called "2-plane" type of gears. In this design as much as possible of the reduction in speed is made in the second or low-speed element, so as to increase the size of the low-speed gear and decrease the high-speed gears. The comparatively small casing thus required for the high speed is carried principally by the upper half of the low-speed casing, the low-speed pinions engaging with the low-speed gear at points near the top of its circumference. The additional support given under the high-speed casing and for the forward foot of the turbine are of a secondary nature only, dependence being placed primarily on the very rigidly-constructed low-speed gear-case. By this means the area of the foundations is reduced to the minimum, being only slightly larger than the horizontal section of the low-speed gear itself. Making the low-speed pinions engage the low-speed gear near the top of the latter also has an additional advantage in that the teeth are less affected by vertical vibrations (which seem to predominate in the structure of the engine-room) than when contact is made on the horizontal centre line.

It is necessary to provide sufficient flexibility between the turbine and gears and between the various members of the gear train to allow the gears and pinions to find their proper running helices or, in other words, to "track" without restraint. The old form of jaw coupling which has been extensively used in turbine work is not considered to be permanently satisfactory though it gives good results when new. Good results have been obtained by the use of hollow pinions and quill shafts connected by pin couplings having floating bushings.

Improvements in hobs and in methods of cutting teeth have enabled teeth to be cut which are correctly formed in the plane of action and which make it possible to obtain not less than 80 per cent. tooth

contact at installation without resorting to the dangerous expedient of grinding in or filing the gears.

The rigidity of the foundation in the ship, and the method of supporting the machinery must be such that the original alignment can be maintained, and the main thrust can protect the low-speed gear from undue vibration and pulsations from the propeller.

Double reduction gears embodying the above features have been built in the United States since the conclusion of the war. After three years' service, representing about 150,000 miles steaming, their condition is so good that it is impossible to estimate their ultimate life, but it is confidently expected that the cost of maintenance during the life of the ship will be in their favour compared with a reciprocating engine.

Since the war, a number of sets of double reduction gearing have been built in Great Britain, and from a study and inspection of these it would seem that many of the difficulties encountered a couple of years previously in the States are now being experienced with these. The interleaved, or "nested" type, as it is known in the United States, has been largely adopted in Great Britain which is a type which many of the best opinions in the United States condemn and practically refuse to build. In this type the helices of one element are spread sufficiently far apart to accommodate the other element between them. This arrangement is as difficult to maintain in proper tooth contact as an element would be if made the full width to the other helices. In most designs of this type, there are also the disadvantages of a large casing area, horizontal meshing of teeth, and it is an arrangement which does not lend itself readily to adjustment of bearings for tooth contact. It would also seem that in the actual machining and in the aligning for tooth contact there is room for much improvement before the standard of the successful American gear is reached.

It is understood that the progress which has been made in the United States in gear design and manufacture has recently been investigated by representatives of prominent British and French shipping interests, and though they went with a decided prejudice against gears from their own experience, their views were very considerably modified by the design, workmanship and performance of the later developments in that country.

Before adopting other forms of propulsion for service in which the geared turbine is eminently suitable, or going back to the reciprocating engine, it would be well to determine beyond question whether many of the troubles which have been experienced with double reduction gears have not arisen from causes which can be overcome with a better knowledge of the art of their design and manufacture. Much of their development was done under the worst possible conditions of rushed production in time of war, and it is doubtful whether any other type of propulsion machinery would show a cleaner record under the circumstances, or a degree of progress in development which would hold a greater promise of ultimate success.

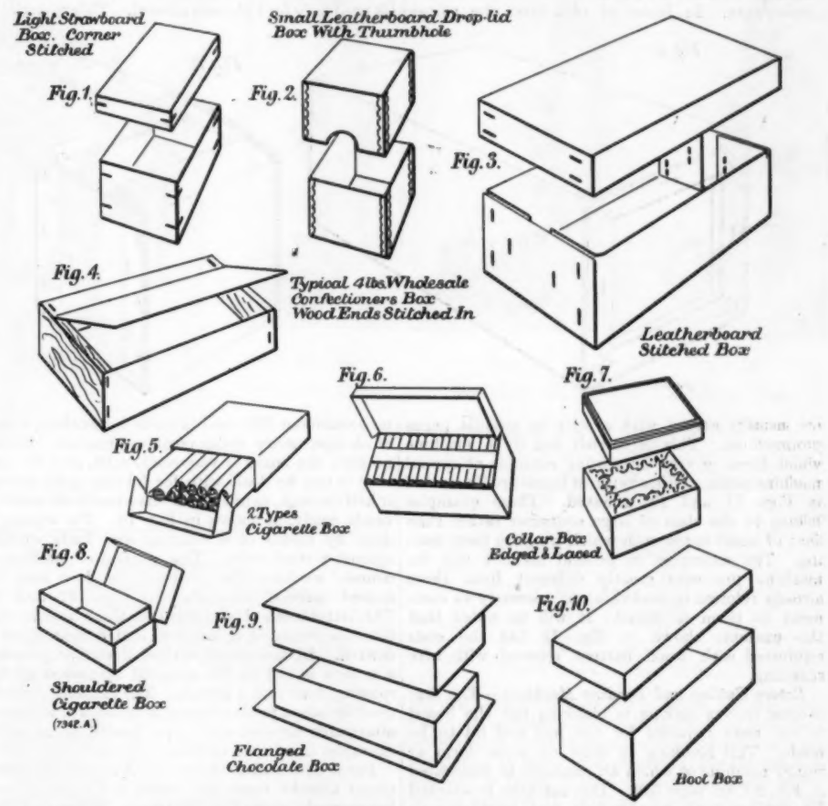
CARDBOARD BOX-MAKING MACHINERY.

ALTHOUGH cardboard boxes in themselves can hardly be described as engineering articles, the machinery by which they are produced is decidedly an engineering matter, and in this series of articles, in which we propose to describe a complete range of machinery used in the manufacture of such boxes, much will be found of great mechanical interest. The subject of cardboard boxes has, moreover, a further aspect which is of importance to engineering manufacturers as well as many others. This has reference to the packing for transport and sale of small articles of all kinds. It is stated that a large part of the trade in files which Great Britain at one time held in South America passed to the United States and Germany chiefly because these countries packed their files in neat cardboard boxes which were easily handled and ensured that the goods arrived on the market undamaged. British files were at that time packed in bundles which were difficult to handle and frequently arrived in that market incomplete, or with the goods damaged.

In this matter of the packing of small articles in cardboard boxes, British manufacturers may, at one time, have displayed a rather conservative attitude, but, nowadays, there is a fairly general realisation of the business value of the presentation of goods to market in an attractive form. A simple matter of packing may determine success or failure. We have knowledge of a case concerning the sale of writing ink in an Eastern market in which success was found to depend entirely on the adoption of a particular type of cardboard box packing for the bottles. We have all heard more than is altogether true about the conservatism of the British manufacturer, but it is certainly true that trade has at times been lost owing to too long adherence to methods which may have proved entirely successful in earlier years. The educative effect of the war effort has, however, opened up new possibilities to many who in the past were content to follow a beaten road, and the value of cardboard box packing is now fairly generally recognised.

Quite apart from the more attractive and convenient nature of cardboard box packing as compared with parcel packing, the box will frequently also prove cheaper. The reason for this, in essence, is that the box is machine-made while the parcel is hand-made. In the case of many articles, box packing is very suitable even for packing which is done in independent units in connection with retail sales, and the collapsible box is coming into use to a considerable extent for this class of service. The details of any installation of box-making machinery will naturally depend on the class of service required. Some manufacturers, making their own boxes, may require only one or two sizes or types, whereas a factory, the whole purpose of which is to make cardboard boxes for sale, may have a very extensive installation of machines of various types. It is not possible in these articles to cover the whole field, but as far as possible descriptions will be given of the individual machines necessary for each particular class of box. The description may be considered to be concerned with an installation of moderate size which yet is laid out to deal with a very miscellaneous class of product.

Before dealing with the machines it will be well briefly to deal with the various classes of cardboard boxes which are usually made, as in this way attention may best be directed to the various operations which have to be provided for. We may first refer to light rigid boxes of types which are in common use for a large variety of purposes. Examples of such boxes are illustrated in Figs. 1 and 2, subjoined. The first of these, that shown in Fig. 1, is a light strawboard box with wire-stitched corners, while Fig. 2 shows a somewhat stronger type of box made of leather-board and with the corners stayed with metal edging. Both of these types of boxes will be very familiar. In the manufacture of either type machines are required for cutting out the blanks. This is done in two operations, strips of material being first cut on a rotary cutting machine and the corners, which have to be removed to allow of the edges being bent upwards to form the box sides, then being removed on a corner cutter. To allow of the material being bent where required it has to be scored or formed in some way along the bend. This necessitates another machine process, which actually is usually carried out before the corners are cut. The scoring or forming necessary varies with the class of material from which the box is being made, and we will refer to this important feature of box-making in detail later. The last machine operation is, of course, the stitching or securing of the edges. If wire-stitching is employed, as in Fig. 1, or metal edging, as in Fig. 2, a machine is used in which the securing material is worked from a roll and is cut-off to length during the box manufacture as required.



The rigid box, shown in Fig. 3, above, is made of leatherboard and, as will be seen, is of somewhat different construction from those already referred to. In this case the box is wire-stitched through the ends and a strong construction results. The arrangement will be clear from the figure. It will also be clear that the blank from which this box is formed is of a different shape from that used in the case of the box shown in Fig. 1. Instead of the corners of the blank being cut out, a slot is made up the side of what becomes the end of the box and the inside flap is thus formed. This introduces a further type of machine operation. A still stronger type of box is formed by the use of wood ends, as illustrated in Fig. 4. In this case the cardboard is secured to the ends by wire stitches, but the

operation is naturally a somewhat different one from the stitching required in the case of the box illustrated in Fig. 1. Boxes of this class, with wood ends, will be very familiar in connection with the confectionary trades.

Boxes of a different type are illustrated in Figs. 5 to 10. These are all very familiar forms and need not be referred to in detail. Their distinguishing characteristic is that they are covered with glazed or fancy paper in order to present a better appearance. Such a box as that shown in Fig. 5 would probably be made up from specially printed board, but in general, boxes of the class illustrated in these figures are covered after they are made up. This covering necessitates a further type of machine. Boxes of these types are always made with butted corners and the corners have to be secured in some way. Wire stitching or metal edging, as illustrated in Figs. 1 and 2, are not very suitable for covered boxes as the paste used for securing the covering would tend to rust the stitching with consequent discolouration, while covering pasted over the metal edging would not lie well and would present a poor appearance. In boxes of this kind the corners

Fig. 11.

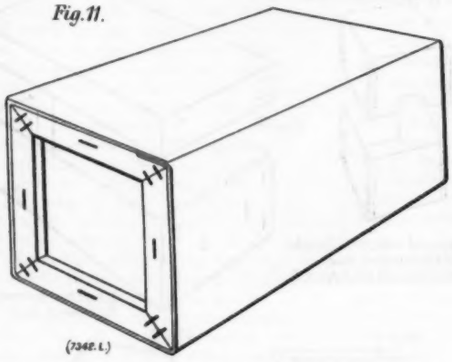
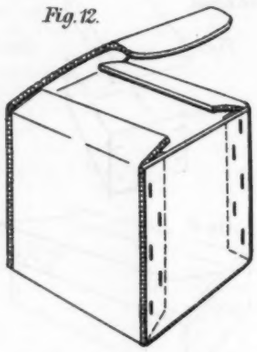


Fig. 12.



are usually stayed with a strip of manilla paper gummed on. This is carried out by a machine which forms a very interesting example of special machine work. Other types of boxes are illustrated in Figs. 11 and 12, annexed. These examples belong to the class of large container rather than that of small boxes with which we have been dealing. The examples in general do not call for machine processes greatly different from those already referred to, and it is not necessary to comment on them in detail. It will be noted that the example shown in Fig. 11 has the ends reinforced with wood battens secured with wire stitching.

Rotary Cutting and Bending Machines.—The first process in box-making is blanking out the board to the sizes required for the box and lid to be made. This blanking is done on some form of rotary machine of which an example is illustrated in Fig. 23, on page 519. This machine is adapted for dealing with strawboards and leatherboards suitable for the class of boxes we have illustrated, and will carry out the scoring or forming of the board to form the edges of the box in one operation with the blanking. This rotary scoring, bending and grooving machine is manufactured by Messrs. Vickers Limited, of Vickers' House, Broadway, Westminster, S.W. 1. Messrs. Vickers are manufacturing a complete range of box-making machinery at their Erith works, and it is to their machines and methods that we propose to refer throughout in this series of articles. Messrs. Vickers' machines are built on the lines previously followed by Messrs. Nasmith, of Stockport, but in most cases the designs have been revised and improved.

As we have said, the machine illustrated in Fig. 23 will carry out the scoring or forming of the board, to form the edges of the box, in one operation with the blanking. To make the procedure perfectly clear, before dealing with the details of the machine, reference may be made to Fig. 13, annexed. This diagrammatically illustrates the blanking and scoring of a sheet which will ultimately form eight boxes. The full lines *a* show where the board is scored right through to form four strips, and the lines *b* the trimming of the edges. On the broken lines *c* the board is scored partly through or treated in some way so that it bends neatly and easily to form the box sides. After the board has been divided into four strips and scored in this way, each strip, either in the same or a similar machine, is divided and scored as shown in Fig. 14, in which the letters stand for similar operations, as in Fig. 13. It will be clear that the strip, as divided and scored in Fig. 14, forms the basis of two boxes. It is naturally not intended to imply that the machine shown in Fig. 24 is suitable only for cutting up board in the particular way shown in Figs. 13 and 14. These figures merely suggest a typical case, and the number of boxes formed from a strip of board of course depends on the size of the stock and of the boxes being made.

Before turning to the details of the machine it will be well to make reference to Figs. 15 to 22, subjoined, which illustrate various ways in which the board can be treated in order that it may bend neatly and form the box corners. The first method, that illustrated in Fig. 15, is known as scoring and is used only for light strawboard. This material has no continuous fibre and is made by working a pulp of chopped straw under medium pressure. Having no fibre the board is very easily split, and the only way it can be dealt with for folding is by cutting it half through, as in Fig. 15. As a result the material bends easily, as shown in Fig. 16. The scoring is done by means of a rotating disc knife working against a steel roller. This method of bending, of course, weakens the material, as does also the second method illustrated in Figs. 17 and 18. This latter method is adapted for thick boards when this weakening is immaterial and a neat finish is desired. In this second method, known as grooving, a groove is cut in the material by means of two rotating discs and a plough. The method is chiefly used for boxes made of heavy strawboard, which are afterwards covered with paper pasted on as in the examples illustrated in Figs. 6 to 10.

For a better class of box, such as tailors' boxes, cheap attaché cases and boxes for holding small heavy goods, such as ball-bearings, leather and fibre board are used. This material has a continuous fibre and can be bent without any cutting and consequent weakening. One of the methods used is illustrated in Figs. 19 and 20. This is known as bending, and is carried out by means of two upper inclined blunt discs and a lower rubber-faced roller. It will be clear that this method does not weaken the board, but merely directs the fibre. A fourth method of treating board is illustrated in Figs. 21 and 22. This is employed when the thickness is not sufficient to bend by the method shown in Figs. 19 and 20, and it is at the same time not admissible to weaken the material by scoring. This method, which is known as creasing, is chiefly used for light printing cardboards for chocolate and cigarette packets. This method is carried out by means of rotating male and female discs, the male with a ridge and the bottom with a furrow. The whole of these bending methods can be carried out on rotary machines. There are other methods carried out on machines of the press type, but we need not deal with these for the moment as the present object is to lead up to a description of the rotary cutting and bending machine.

As already stated, the Vickers' machine, illustrated in Fig. 23, will both cut and score the board. In some cases, however, an independent cutting machine will be used. This is naturally a matter depending on the amount of repetition work being done, or other special factory conditions. The matter also depends on the kind of board being dealt with. Thus, for light strawboard, a combined rotary and scoring machine would in general be used, whereas, when dealing with heavy leatherboard, an independent cutting machine would probably be employed, and the blanks would afterwards be put through a bending machine. A pure cutting machine does not differ in its general lines from the machine shown in Fig 23, but being a single-purpose tool is naturally somewhat simpler. The method of cutting is the same for all types of board, and consists of a pair, or pairs, of cutting discs arranged one above the other and giving a scissors-like action. The cutting machine is fitted with feed rollers, a planed iron feed-table and a wood receiving box into which the blanks are fed. As, however, all the features of the simple rotary cutting-machine are incorporated in the cutting and scoring

Fig. 13.

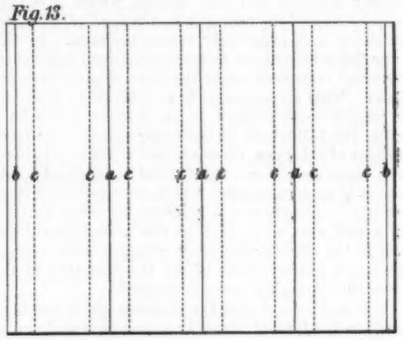


Fig. 14.

Fig. 15.

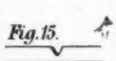


Fig. 16.

Fig. 17.

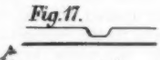


Fig. 18.

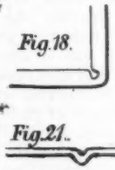


Fig. 19.

Fig. 20.

Fig. 21.

Fig. 22.

machine shown in Fig. 23, we may at once pass to that more general-purpose tool.

This machine consists essentially of a framework carrying the horizontal feed table on which the board to be operated on lies. At the back of the table the feed, cutting, and scoring rollers are carried from housings mounted on the side pedestals. A driving shaft, with fast and loose belt pulleys, is carried below the table, as can be seen in the figure. The rollers are driven from this shaft by machine-cut gearing which is provided with a cover. The feed rollers serve to propel the board. The lower one is positively driven, while the upper one, which is free, is carried in a hinged, adjustable bracket so that the distance between the rollers may be adjusted for different thicknesses of work. Behind the feed rollers the cutting shafts are situated. These carry circular steel cutters working in pairs and adjustable endwise for position so that blanks of any size may be cut. Behind the cutting shafts the scoring roll and tools are situated so that the board passes through this mechanism

before it reaches the delivery box. The scoring roller is smooth and ground all over, and the scoring tools are carried above it, being fixed to and adjustable along the tool beam which can clearly be seen in the figure.

The scoring tool is of the type shown in Fig. 24, subjoined. It consists of a steel disc, $2\frac{3}{8}$-in. diameter and bevelled to a sharp edge. The disc is mounted on a cast-steel arbour revolving in a cast-steel bush, the bush being carried by the holder which is clamped to the tool beam. The shape of the tool holder is such that the tool comes directly over the scoring roller and by adjusting the height of the tool by the screw carried in the shank the board may be scored to any depth desired. The scoring tool and roller may be used for cutting the board if desired. This is done merely by setting the tool low enough to almost sever the board, so that it may immediately be broken by hand when taken out of the receiving box. The main table of the machine is usually made with a gap which, when work is being carried out, is filled by a gap board. The arrangement can be seen in Fig. 23. The object of the gap is to enable the operator to get close up to the rollers when tool setting.

A feed-bar is supplied in connection with the table and is shown in position in Fig. 23. This consists of a straight-edge fitted with a handle and formed with a lug on its lower side which works in a slot in the table. The bar is used for pushing the board forward until it enters the feed rollers. A semi-automatic feed arrangement is also manufactured. This takes the form of two sliding racks mounted one on either side of the feed table. The racks have a series of notches along their top edges so that a feed bar can be dropped into any position along them. The racks are moved to and from the feed rolls by means of rocking levers keyed to either end of a cross-shaft, to which a reciprocating motion is imparted by a crank and connecting rod. The arrangement results in a to-and-fro motion of the feed bar, and is of great value for some work, as, for instance, in cross-scoring a number of strips of the class illustrated in Fig. 14.

A further feature of the feed table to which reference should be made, is the side gauges which are fitted to ensure that the stock is presented square to the feed rollers. The gauge to be seen at the right hand side of the table in Fig. 23 is a standard fitment for all rotary machines. It is mounted on swinging links carried by brackets mounted on the edge of the table. The advantages of this construction are that the gauge, though adjustable, may be swung out of position and clear of the table at any time when it is not required and at the same time, when swung back, it is at once in the correct position and requires no re-setting of any kind. Two loose adjustable side gauges are also provided in connection with the hand-feed bar. They are shown mounted on the bar in Fig. 23, and are used for cross-feeding small strips. The gauge to be seen lying on the left of the table in the illustration is an auxiliary fixed side gauge intended for use when it is desired to feed from the left for any particular run. Other features of the machine will be fairly clear from the illustration.

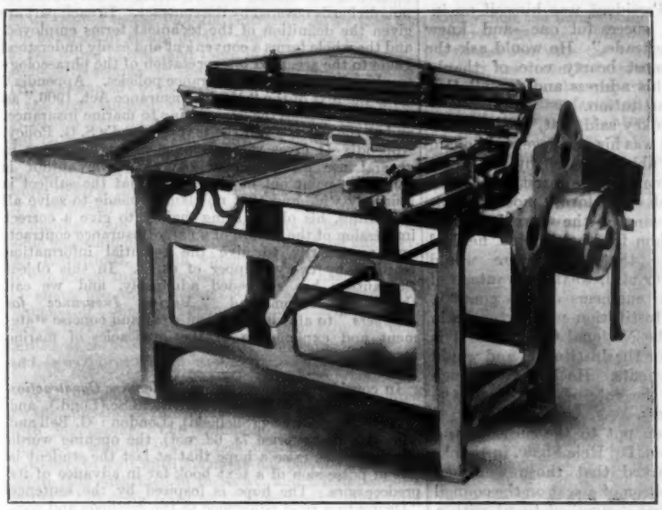


Fig. 23. Rotary Cutting and Scoring Machine.

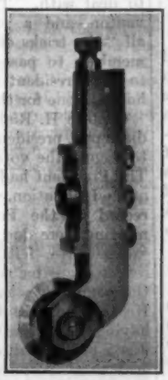
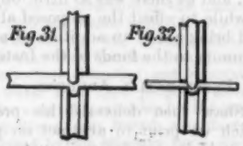


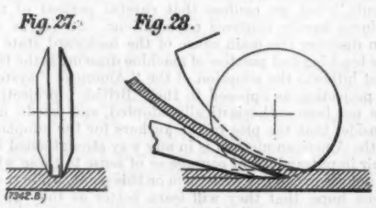
Fig. 24. Scoring Tool.

Fig. 25. Grooving Tool.

Fig. 26. Bending Tool.



Thick Board. *Thin Board.*



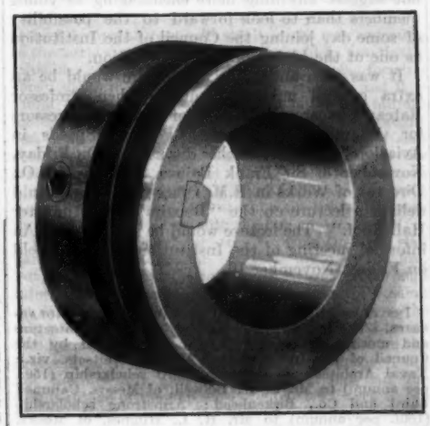


Fig. 29. Bending Disc.

A large hand wheel is fixed on the main shaft at the opposite end from the belt pulleys for use when setting up. The working speed of the machine is at the rate of 2 ft. of passage of board per second. The average output is 3,000 to 4,000 blanks an hour, and the power consumption is $\frac{1}{4}$ h.p. to $\frac{1}{2}$ h.p.

Machines for grooving and bending are built on the same lines as the cutting and scoring machine shown in Fig. 23, and it is not necessary in dealing with these processes that we should do more than refer to the tools which are used. The grooving tool is illustrated in Fig. 25, and sketches explaining its action quite clearly are given in Figs. 27 and 28. As will be seen, the arrangement consists of a pair of sharp-edged steel discs with a grooving plough set between them. A clearing guide is fixed behind the plough which gives a gradually increasing throat area and directs the shavings. Standard tools range from a groove $\frac{1}{4}$ in. wide to $\frac{3}{32}$ in. wide. When heavy grooving is being done it may be necessary to assist the driving action of the feed rollers of the machine. This is done by a feeding tool which is carried in a holder of the same type as those shown in Figs. 24 and 25. The tool consists of a flat-leather treaded wheel, which is adjusted up or down by the adjusting screw carried by the holder. The tool is, of course, set so that the wheel comes directly above the lower positively-driven smooth roller of the machine and the work is gripped between the wheel and the roller.

The bending tool, which consists of a pair of inclined blunt discs, is illustrated in Fig. 26. This forms the board being treated to the shape shown in Fig. 19 and, as will be clear from this figure, the work cannot be carried out with a smooth lower roller. It is, indeed, merely in the form of this lower roller that a bending machine differs from a scoring machine. In place of the smooth roller the bending machine is fitted with a gear-driven shaft which carries a series of bending bosses adjustable for position along its length. These bending bosses are turned on their circumference with a pair of grooves which are fitted with hard rubber rings which form cushions below the bending discs. A bending disc is illustrated in Fig. 29. The form of the bosses is such that a ring stands up above the level of the rubber rings and forms a ridge over which the board is bent. The action will be understood from Fig. 30, in which the rubber rings are shown cross-hatched. The inclination of the discs of the bending tool can be varied to regulate the width of bend to suit the thickness of board being dealt with.

The final method of treating board on a rotary machine in order that it may bend properly to form box corners is that known as creasing and illustrated in Fig. 21. This operation is carried out in a creasing machine which again is generally on the lines of the cutting and scoring machine shown in Fig. 23, but instead of independent tools of the class with which we have been dealing, it is fitted with positively-driven pairs of creasing bosses, working directly one over the other. The upper boss is formed with a rib and the lower with a groove into which the rib meshes. To suit various thicknesses of board, the shaft carrying the upper bosses is mounted in

eccentric housings at either end. These housings can be rotated in unison by a handwheel at the side of the machine, so raising or lowering the top shaft in relation to the lower one and controlling the distance between the boss rims. The action of the two bosses in creasing the board will be understood without further comment, but reference may be made to Figs. 31 and 32, on page 519, which show the two bosses in relation to the material, and set for thick and thin board respectively.

(To be continued.)

THE INSTITUTION OF MECHANICAL ENGINEERS.

An ordinary general meeting of the above Institution was held on Friday last, at 6 p.m., at Storey's Gate, Westminster, the President, Dr. H. S. Hele-Shaw, occupying the chair.

The Late Professor H. Hubert.

The minutes of the summer meeting at Paris and Liége having been read, Dr. Hele-Shaw referred to the recent death of Professor H. Hubert, the senior professor in the Univeristy of Liége, who had so warmly welcomed members of the Institution of Mechanical Engineers on the occasion of their recent visit to Liége. Professor Hubert was one of the most distinguished of Continental scientists. The council had decided to send on behalf of the Institution a letter of condolence to Madame Hubert.

Alteration of By-Laws.

The secretary then read the formal notice, in conformity with the Articles of Association, with regard to the proposed alteration of the by-laws of the Institution, to the effect that resolutions would be moved at the general meeting on Friday, November 17 next. The President then explained the alterations proposed which related to the difference in subscriptions to the Institution of members resident in the United Kingdom and abroad. For long there had been no difference, but at present it was the practice to charge a less annual subscription to members resident abroad. Members resident abroad, however, did not object to paying the full subscription, and as there was so little objection it was worth while to effect the proposed alterations, which would bring about an addition of more than 1,000*l.* per annum to the funds of the Institution.

Presidential Address.

Dr. Hele-Shaw then delivered his presidential address, which we print in abstract on page 538 of this issue. At its conclusion a vote of thanks was proposed by Dr. W. H. Maw, who remarked that it had been his good fortune to be on intimate terms with Dr. Hele-Shaw for a great many years, and he had long ago learnt that one of that gentleman's most striking characteristics was, if he might say so, the habit of "breaking out in a fresh place." Never had a presidential address been delivered in the hall of the Institution which at all resembled that of Dr. Hele-Shaw. Had he been asked to suggest a motto to head the address he would have proposed "Business first and pleasure afterwards." He desired to congratulate the President on the manner in which he had dealt with the new arrangements for membership and for examinations. He felt that a good deal of misunderstanding had arisen in relation to the new arrangements; and, he would suggest that members should most carefully read that part of the address. Dr. Hele-Shaw had dealt in an admirable way with the motives which had suggested the changes.

The latter part of Dr. Hele-Shaw's address recalled many pleasant memories to his mind. It was now over sixty-two years since he had become acquainted with the inner workings of the Institution. In April, 1860, he was serving under Mr. Robert Sinclair, chief engineer of the Great Eastern Railway and Consulting engineer to the East Indian Railway. He had been entrusted by Mr. Sinclair with the design of some outside cylinder locomotives for the East Indian Railway, and in this connection it was desirable that he should reside at Birmingham while that work was being done. Mr. Sinclair secured for him an office in the premises of the Institution of Mechanical Engineers, which were then in Birmingham. He became very intimate with the then secretary, Mr. Marshall, and with the subsequent secretary, Mr. Bache. The Institution was then a provincial institution, and, as such, its progress was very slow. After a great struggle, however, the headquarters were shifted to London, and real progress was then made. That was the critical point in the Institution's history. The next critical point was when, some twenty-five years ago, the Institution secured premises of its own, from which time the progress made had been really remarkable. The second part of the President's address, that dealing with inventions, had undoubtedly afforded much pleasure to all present. During the last fifty years, he (Dr. Maw) had been brought into very intimate contact with inventors, and had found them a very difficult class of men to deal with. The President was himself an inventor—and a most successful one—and knew all "the tricks of the trade." He would ask the members to pass a most hearty vote of thanks to the President for his address and for all that he had done for the Institution.

Captain H. Riall Sankey said that, as the immediate past president, it was his privilege and honour to second the vote so ably proposed by Dr. Maw. The President had given a very interesting account of the Institution, which would form a most valuable record in the Proceedings; the thanks of the meeting were due to him for the trouble he had taken. He felt sure that the future would reflect a greater activity still, to the advantage of the coming mechanical engineers of this country. He thought that the Institution was fortunate in having to deal with the National Certificates; it was a proud position for the Institution and would lead to all sorts of benefits. He had very much pleasure in seconding the vote of thanks to the President for his address.

The vote having been put to the meeting and passed with acclamation, Dr. Hele-Shaw, in thanking the members remarked that those who had not yet reached the position of a seat on the council could not appreciate what it signified to sit with a body of men so devoted to the interests not merely of the Institution but of engineering. He could not suggest anything more encouraging to young members than to look forward to the possibility of some day joining the Council of the Institution as one of the higher objects of ambition.

It was then announced that there would be an extra general meeting to-night, when Professor Rateau's paper on "The Use of Turbo-Compressors for Attaining the Greatest Possible Speeds in Aviation" would be further discussed. On Friday, November 3, Sir Frank Baines, C.B.E., M.V.O., Director of Works in H.M. Office of Works, would deliver a lecture on the "Repairs of Westminster Hall Roof." The lecture would be illustrated. An informal meeting of the Institution would be held on Friday, November 10.

Institution of Naval Architects: Scholarships.—The following scholarships in naval architecture and marine engineering have been awarded by the Council of the Institution of Naval Architects, viz.: Naval Architecture—Cammell Laird scholarship (150*l.* per annum) to Mr. S. W. Bolwell, of Messrs. Cammell Laird and Co., Birkenhead; Armstrong scholarship (150*l.* per annum) to Mr. R. L. Hughes, of Messrs. Cammell Laird and Co., Birkenhead. Marine Engineering—Parsons scholarship (150*l.* per annum) to Mr. C. E. Moffatt, of H.M. Dockyard, Devonport; John Brown Scholarship (150*l.* per annum) to Mr. Donald Campbell, of Fairfield Shipbuilding and Engineering Company, Govan, Glasgow.

The Industries of Philadelphia.—The manufacture of textiles has always been the leading industry in Philadelphia, says *Commercial America*. The value in 1921—398,422,400 dols.—was 28·4 per cent. of that of all manufactured products, as against 554,831,400 dols., or 25 per cent. in 1920. This class is made up of textile fabrics, clothing and allied products. About three-fourths of the production in Philadelphia consists of textile fabrics and one-fourth of clothing and accessories. Metals ranked second among the industries of Philadelphia, the total value in 1921 being 265,144,000 dols., or 19 per cent. of the total, as against 461,350,000 dols., or 21 per cent., in 1920. At one time Philadelphia was the leading manufacturer of iron and steel products, but it is now outranked by Pittsburgh, Chicago and other cities, because of their easy access to a supply of cheap ore and other advantages.

NOTES ON NEW BOOKS.

To those shippers—and their number must be very large—to whom the technicalities of cargo insurance are at best but imperfectly understood, the handbook entitled "*Marine Insurance for the Shipper*," by Joshua Lea, and published by *The Manchester Guardian*, Limited, Guardian Buildings, Manchester, price 1*s.*, is certain to prove both interesting and valuable. Couched as it is in the legal phraseology of about 300 years ago, the insurance policy may well prove a veritable trap for the unwary insurer, but as the author points out, the retention of the old form of words is justified by the fact that successive legal decisions over this long period of years have amply defined the exact meaning of the form used. Methods of affecting insurances through brokers or by direct negotiation with underwriters are explained in Part I. Parts II, III, and IV explain the general principles upon which the insurance contract is based; the definition of the liability assumed by the underwriter in terms of the contract; and the method of calculating and adjusting claims which are not obviously covered by the contract. In each part are given the definition of the technical terms employed, and the whole forms a convenient and easily understood guide to the accepted interpretation of the phraseology employed in the text of insurance policies. Appendix I gives the text of the "Marine Insurance Act, 1906," an Act which codifies the law relating to marine insurance, and at the end is given the text of Lloyd's S. G. Policy. Appendix II gives the substance of trade clauses in general use for particular cargoes. The author is careful to point out in his preface that the subject is infinitely wide and that no claim is made to solve all difficulties, his object being mainly to give a correct impression of the nature of a cargo insurance contract, and secondarily to give the essential information required by every shipper of cargo. In this object the author has succeeded admirably, and we can thoroughly recommend "*Marine Insurance for Shippers*" to all who require a clear and concise statement and explanation of the intricacies of marine insurance.

In considering the merits of "*Machine Construction and Drawing*," by Henry E. Merritt, B.Sc.(Lond.), and Maurice Platt, M.Eng.(Sheffield), (London: G. Bell and Sons, Limited; price 7*s.* 6*d.* net). the opening words of the preface raise a hope that at last the student is put in possession of a text book far in advance of its predecessors. The hope is inspired by the sentence "Owing to a rigid adherence to the methods and conventions laid down by the devotees of the 2-ft. rule, the teaching of '*Machine Construction and Drawing*' is to a large extent out of touch with modern requirements," but we confess that careful perusal of the volume hardly confirms expectations. So far as we can discover the main cause of the backward state of the teaching and practice of machine drawing is the fact that hitherto the adoption of the "American" system of projection as opposed to the "British" projection has not been enthusiastically adopted, and we do not consider that the plea of the authors for the adoption of the American method is in any way strengthened by their imputing lack of courage or of sense to those who do not see eye to eye with them on this point, while their pious hope that they will learn better as they grow older is merely childish. In the chapter describing drawing materials and instruments we note that the student is advised to correct any error in his set squares by "judicious scraping with a sharp knife." We would not care to use a set square so treated and would advise the use of a small hand plane or a sheet of fine sand paper. Again, we believe that 95 per cent. of draughtsmen will emphatically disagree with the statement that a chisel or flat point can be made on a pencil as well with a knife as with a file. These are small items, but none the less important to a student commencing machine drawing. The chapter on Riveted Joints contains much that is misleading and would lead the student of naval architecture into serious trouble with his teacher. For instance, it is stated that rivets are manufactured with points slightly tapered. If plug or conical necks are meant, this should be made clear, but certainly tapered rivet shanks are rarely, if ever, met with in practice. The hammered-up end of a rivet is invariably referred to as the "point" whatever its final shape and not the "second head" as stated by the authors, and it may be pointed out that a dead flush countersunk point as illustrated and described as used in ship plating would be promptly condemned by any superintendent who knew his business. Again, the statement that the cheapest and worst way of forming rivet holes in plating is to punch them, is, in view of the fact that probably 90 per cent. of all holes in ship work are punched, a statement which is certainly open to question from the purely academic point of view, and is indefensible from the practical point of view. We are afraid that the caulking of steel plate edges in practice has only come within the knowledge of the authors in a very limited degree and would strongly

advise that the subject matter of riveting and caulking be revised by a competent practical ironworker. In spite of the defects pointed out there is much that is good in the book, the reproduction of the drawings and the selection and grading of the examples being excellent. There is in the volume the making of a thoroughly useful textbook, and we regard the general arrangement and the subject-matter as most satisfactory.

Technical works may be divided into two classes, viz., those intended for the learner, and books devised to act as a "refresher" for those who having at one time "gone through the mill," have through concentration on a limited and specialised class of work, lost touch with general principles. In text books for the learner, descriptions and explanations can hardly be too minute, but this wealth of detail is not required in a reference book, though the field covered must be extensive. This requirement is well filled by "*Modern Practice in Heat Engines*," published by Messrs. Longmans Green and Co., at 15*s.* net. In some 250 pages the author, Mr. Telford Petrie, M.Sc., lecturer on mechanics in the Victoria University, deals with the whole range of steam engine practice from the boiler to the prime mover, and there is also an equally comprehensive section on the internal-combustion engine. The field appears to be covered as fully as is practicable in the space allotted, whilst copious references are given to papers and publications where further particulars can be found, should more detailed data be required on special points. These references greatly enhance the utility of Mr. Petrie's work, as few occupations are more dreary than a hunt through the Proceedings of a technical society in the hope, often frustrated, of finding there a paper known to have been read at some uncertain date before one or other of our engineering institutions, though which one may be unknown. In the steam turbine section the author has been able to make use of Professor Stoney's lectures at the Manchester College of Technology, and the chapters on steam turbine design will be welcomed by all concerned in turbine construction. The volume, we may add, is well printed and lavishly illustrated.

It is not unusual for the politician to be honoured by the appearance during his lifetime of a book dealing with his career. The common man, such as the engineer, who moves in less exalted spheres, has, however, to wait until his name has become a memory before it is enshrined in this way, and the appearance of the "*Life of Sir Guilford L. Molesworth*" must form an almost unique example of an engineer being so honoured in his lifetime. The publication of the book is, however, not difficult to understand. Sir Guilford in the sub-title is called "The Nestor of the Engineering Profession," and the phrase is a just one. His long and distinguished career have given him a place in engineering work which is not quite paralleled by anyone else. Much of Sir Guilford's professional life has, of course, been spent in India, and an interesting but somewhat desultory account of his work there is given in the book. In a sense the book is rather an appreciation than a formal biography, but the main facts of Sir Guilford's career are given, and the intellectual honesty and outspokenness which form such a distinguishing feature of his character are well illustrated. To the average and particularly to the younger engineer of the present day Sir Guilford Molesworth is probably best known through his famous pocket book, and such engineers will be interested to hear that the book, which first appeared in 1862, was refused by the great engineering publisher Weale. It was finally brought out by Spon and passed through six editions in its first year. In view of the fact that the book is still in very active existence and has reached its twenty-eighth edition, it is seemly that the present life should be published by the same firm—Messrs. E. and F. N. Spon, of 57, Haymarket, London, S.W. 1. The book is published at 5*s.* net, and has been compiled by Mr. E. J. Molesworth.

The Food Investigation Board.—The report for 1921 of the Food Investigation Board (H.M. Stationery Office; price 2*s.* net), recently published, refers to various investigations conducted under the ægis of the Engineering Committee at the National Physical Laboratory and the Engineering Laboratory, Oxford. At the National Physical Laboratory the work under Dr. Ezra Griffiths dealt with industrial types of hygrometers, the phenomenon of heat transmission by convection, and the conductivity of materials employed in the construction of cold stores. The work at Oxford dealt largely with ethyl chloride. It may be pointed out that at the recent joint discussion of the Faraday Society and the British Cold Storage and Ice Association (page 499 *ante*), Dr. Griffiths contributed a paper on "The Conductivity of Materials," and Professor C. F. Jenkin one on "Ethyl Chloride," both of which cover work done in connection with the Food Investigation Board's researches. A report on heat transmission by convection is in preparation. The Cars and Barges Sub-Committee has completed its investigation on the experimental refrigerator barge, and a report will be presented shortly.

SLAG ON BOILER TUBES.

To obtain the highest efficiency of a boiler plant it is necessary to reduce the excess air passing to the furnace to the lowest possible amount, the degree to which the excess air is reduced being, of course, indicated by the readings of the CO_2 recorder. The limitation of excess air results in a corresponding rise of the furnace temperature as the fires are no longer flooded with cold air. A high furnace temperature is very desirable from the theoretical point of view, but it may bring its own peculiar troubles in the form of melted brickwork and collapsed arches. The cure for these events is not to revert to former uneconomical conditions, but to use better bricks and, if necessary, to avoid arches altogether. Another source of trouble is the fusing of slag on the boiler tubes, this having been observed principally in connection with the burning of powdered fuel, when not only is a very high furnace temperature obtained on account of the ease of air control, but the ash in the fuel is presented in conditions favourable to deposition on any surface with which the flames come in contact. There have, however, also been cases of trouble from this source in connection with the burning of solid fuel and the subject has recently been investigated by Mr. H. E. Bates, of the stoker department of the Westinghouse Electric and Manufacturing Company, of Philadelphia.

Mr. Bates appears to attribute the trouble to pyrites in the coal, the iron of the pyrites combining with silica and lime to form a slag which was fusible at a temperature considerably lower than was often obtained in working conditions. The iron in such a slag was in the ferrous state. Contact with sufficient oxygen

at high temperature would result in the iron oxidising to the ferric state, in which state it would be practically infusible. The complete oxidisation of the slag-forming constituents in the fuel bed is impracticable, and it is found that even with low gas velocities the minute molten slag particles are carried along with the draught and deposited on the tubes. If the particles of slag could remain in contact with the free oxygen in the furnace gas for a sufficient time, they would become completely oxidised and therefore infusible. In such a condition they would not stick on the tubes, but pass away as solid ash along with the flue gases.

The obvious cure for trouble from molten slag particles is the admission of excess air over the fire, but the effective distribution of such air and its thorough intermixture with the gases is in the author's opinion an extremely difficult problem. In order to give the slag particles more time to become oxidised and therefore harmless, he raised the boiler 6 ft. higher from the grates than it was originally set. This, however, did not produce any great improvement, and had the disadvantage of the exposure of more brickwork to the furnace temperature. He arrived eventually at the conclusion that the trouble from slag deposition could be minimised by adopting a greater ratio between the tube surface exposed to the fire, and the area of the grate. In the boiler experimented on these surfaces were equal, and the condition which the boiler got into may be gathered from the photograph of the tubes reproduced above. With tubes in such a state, of course, anything approaching efficient working was impossible, and indeed the slag deposit actually blocked the space between the tubes over considerable areas. A similar boiler fired with similar coal on a similar stoker, in a neighbouring power plant gave no trouble from slagging, but in this case the boiler tubes were not staggered. It appeared that the passage of the slag between the first two tubes cooled it sufficiently to prevent its adhesion. The author remarks that in modern boilers, the ratio of exposed tube surface to grate surface, is commonly as high as 187 : 100, and is seldom less than 120 : 100, and by increasing this ratio the furnace temperature is reduced. This he considered a step in the right direction, but it may be pointed out that no alteration of this ratio can bring about the oxidisation of the slag which he desires, and if conditions are so bad that nothing but a reduction in furnace temperature will meet the case, then this might better be obtained by admitting excess air over the fire. Such excess air would not only reduce temperature but would also have the effect of assisting the oxidisation of the slag.

AGRICULTURAL DRAINING MACHINERY.

The enthusiasts who, knowing little or nothing about practical agriculture, have endeavoured to persuade farmers that their prosperity would be assured if only they would employ sufficient machinery, have done considerable harm to the cause they advocated. Their successes in salesmanship were in many cases Pyrrhic victories, and to-day there is many a tractor abandoned and rusting itself away in a ditch or hedgeside, as a warning to every passer by that complicated machinery will not "run itself." It is as absurd to expect a farmer and his staff to be expert mechanics as to expect an engineering firm to be proficient in the cultivation of wheat or wool. Agriculture to-day is in a highly critical condition, and the unfortunate experience of many farmers with expensive machinery is making others reluctant to adapt mechanical power when it would be greatly to their advantage to do so. This fact is recognised by the Ministry of Agriculture, and the Department has therefore set itself the task of securing reliable data as to actual operating costs and capacity of various types of machinery, so that farmers may be advised as to the economic results likely to be obtained under any particular conditions.

In pursuance of this policy the Department organised trials of draining machinery last year in Lincolnshire on a fairly extensive scale. On Wednesday and Thursday last similar trials were held near Tonbridge, in Kent, in conjunction with the Agricultural Education Committee and the West Kent Branch of the National Farmers' Union. Unfortunately the stringency of financial conditions somewhat limited the scope of these latter trials, but they nevertheless served to provide useful data, and at the same time afforded the agriculturists of the neighbourhood an opportunity of examining the behaviour of various machines under actual working conditions. The weather fortunately was admirable, and the farm on which the demonstration took place had a subsoil of the Wealden clay, which is clay in the strongest sense of the word. It was therefore very suitable for the drainage work which was one of the special features of the demonstration.

Drainage, in the agricultural sense, is concerned with the making and cleaning of open ditches or dykes, and the construction of the underground work through which the water finds its way into the open ditches. Considering the ditches first, one of the troubles is that they become choked with weeds and require periodical cleansing and renovating in order that the water may flow properly along them. As inquiries for a suitable machine for the purpose resulted in no suggestions from British manufacturers, designs were produced by the Ministry for a grab-ditcher, the construction of which was undertaken by Messrs. Priestman Bros., Limited, of Hull. This machine consisted essentially of a jib-crane construction equipped with a Priestman grab and mounted on a turntable carried upon a travelling carriage. Power was furnished by a shaft with universal joints, which connected the mechanism to the engine of a caterpillar tractor. The tractor, of course, also served to pull the machine into position and traverse it along the edge of the dyke. It was in this form that the Priestman grab-ditcher was demonstrated at Tonbridge, an extremely dirty pond providing a suitable scope for its activities. The makers, however, have very recently introduced a new model, and this we illustrate in Fig. 1 on page 522.

The new Priestman grab-ditcher is self-contained, and carries its own power for operation and propulsion. The general nature of the design will be clear from the illustration. It travels on two broad caterpillar tracks with wooden treads. It is provided with a two-cylinder slow speed Saunderson internal-combustion engine of 20 b.h.p. to 25 b.h.p. mounted on the foot-plate. The grab which holds 6 cub. ft., as compared with 3 cub. ft. only in the former model, can be operated at a radius of 20 ft., and will remove 25 cub. yards of mud or slurry per hour. The weight of the machine in working order is 7 tons, but it can be operated on the softest ground on account of the great bearing surface provided by its chain tracks. A machine of somewhat similar type, although very much lighter and designed primarily for a different duty, was the Clayden portable crane, manufactured by Herbert Alexander and Co., Limited, of Charmouth-street, Leeds. This, when we saw it, was taking farmyard manure from an old and well-consolidated pile and loading it into dung carts. It is a most handy and attractive machine, but as we have already illus-

trated it in these columns, we need only now describe it in outline. It is a small swinging jib crane mounted on a travelling platform and carrying an automatic digging grab raised by a 2·5 b.h.p. Petter oil engine and winch gear. One man is sufficient to operate the crane, and this may well be the carter himself if the horse will stand, as all good carthorses will, without attention. A single cord controls the motions of the grab, raising, lowering or stopping it as may be desired, the engine of course running all the time. By replacing the grab with a sack-holder the machine may be used for loading grain, or when no loading is required, the engine can be belted to any kind of farm machinery. The lifting capacity of the machine used as a crane is 5 cwt. at a speed of 157 ft. per minute.

Considerable interest was shown in the progress of a "Buckeye" drain excavator, lent by Sir Douglas Newton, of Croxton Farm, St. Neots, for demonstration purposes. This is a large self-propelled machine of American manufacture and design. It was employed in cutting the trench for the main drain of a field, the trench afterwards to contain 8-in. earthenware pipes buried well below the depth of cultivation. The cutting implement was a circular ring furnished with buckets round its edge and carried by roller-wheels on a frame at the back of the machine. The ring was driven by a small sprocket engaging with teeth on the ring, all the reduction from the engine speed being brought about by sprocket chains. The frame carrying the bucket-ring could be raised and lowered bodily on vertical slides, to regulate the depth of trenching. When we saw it the machine was cutting a trench about 11 in. wide and 2 ft. 6 in. deep at one operation through clay of the stiffest possible nature, and was making very good work. The spoil scooped up on the buckets was kept in them, until they reached the top of their path, by a fixed iron plate which fitted inside the ring for a part of its circumference and acted as an inner side to the buckets. At the required position the buckets passed over fixed iron rods which positively pushed out the clay, so that it fell on to a travelling conveyor which deposited it at the side of the ditch. The whole machine progressed slowly along on caterpillar tracks as it worked. We understood that it could just as readily cut a ditch up to 5 ft. 6 in. in depth, and at the Lincolnshire trials it is said to have cut a ditch 4 ft. 6 in. deep and 154 yards long through very heavy land in 50 minutes. It is a most interesting machine, but essentially one for the contractor rather than for the individual farmer. Main drainage trenches were also being cut at Tonbridge by the Revolt drain excavator, made by the South Lincolnshire Agricultural Engineering Company, Limited, of Spalding, Lincolnshire. The Revolt machine is a very light and simple implement which cuts the trench a few inches deep only at one passage so that it traverses over the work until the required depth is attained. The horizontal cut is made by the sharp-edged nose of the implement and a steel elevator band removes the material and deposits it at the side of the trench.

The ordinary small drains which feed the main arterial drains are merely holes through the ground, and some people may be surprised to learn that they fulfil their functions for 20 years and more without renewal. They are, of course, well below the greatest depth to which ordinary agricultural operations disturb the earth, and as artificial drainage is only needed in very stiff clay soils, the conditions are favourable to their lengthy existence. These drains are made by "mole-ploughs," of which one, as manufactured by Messrs. F. B. Wells and Son, of Burleigh, Welwyn, Herts., is shown in Fig. 2, annexed. The plough consists of a steel frame on two land-wheels, and projecting downwards from the frame is a knife plate about ½ in. thick, carrying the "mole" at the bottom. The mole is a hardened cylinder, held horizontally, and with the front and back ends cut off at a fairly sharp angle. In the machine illustrated the mole is 2·5 in. diameter, and is adjustable to a depth of 22 in. below the ground level. Similar machines are made with larger moles and greater adjustment, but the very deep drainage which was formerly advocated is now realised to be less effective than drainage at a moderate depth. The mole, when hauled by a cable-ploughing outfit, goes through the ground as fast as a man can comfortably walk, and the machine merely leaves a narrow slit in the ground, which almost at once closes in. Mole ploughing was being done in the same field at Tonbridge with a steam ploughing tackle made by Messrs. John Fowler and Sons, Limited, of Leeds, and by an oil-ploughing outfit by A. Borsig, of Tegel, near Berlin. The latter was exhibited by Mr. F. A. Standen, of Standpoint Works, St. Ives, Hunts., who holds the concession for the Borsig machines in this country. We mentioned the Borsig cable tackle in connection with our review of the Royal Agricultural Show at Darlington, and pointed out then how very favourably it compared in many respects with some of our own designs.

AGRICULTURAL DRAINING MACHINERY.

Fig. 1. Caterpillar Ditching Grab; Messrs. Priestman Brothers, Limited, Hull.

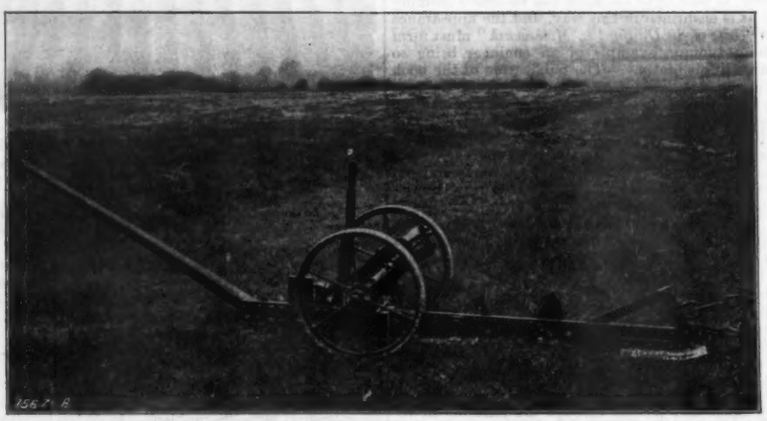


Fig. 2. Mole Plough; Messrs. F. B. Wells and Son, Burleigh, Welwyn, Herts.

Each machine consists merely of a horizontal open-type heavy oil engine, with one cylinder only, geared in the usual way with the travelling wheels and with a winding drum. The machines were working with crude benzol, and the whole operating staff consisted only of three men, one at each engine and one following the plough. The extreme simplicity of the design and the obvious strength of the parts made the machine eminently suitable for agricultural purposes, and we have authority for saying that, as might be expected, its total operating cost was far below that of steam tackle or agricultural tractors doing the same work. The type is one which from every point of view deserves the close attention of our own manufacturers, particularly those who specialise in cable ploughing tackle driven by internal combustion engines.

The trials at Tonbridge were conducted under the supervision of Mr. H. G. Richardson, head of the Machinery Department of the Ministry of Agriculture, together with Mr. Thompson Close and Capt. J. B. Owen, engineers to the Department. The results, in conjunction with those of previous trials of the series, will be analysed and tabulated in a forthcoming report on "Drainage and Subsoiling Machinery," in which will be given mechanical details of all machinery tested with particulars of performance. It is intended in this report to reduce the cost of the operations performed by each machine to a common basis, so that useful comparisons can be made not only between the machines themselves, but as to the cost of machine *versus* horse or hand labour under any particular circumstances. The economic question will quite properly be given prominence, with a view to co-ordinating the increased yield of land drained in various ways with the cost of effecting the drainage.

The Federation of British Industries.—The Federation of British Industries announce that it was unanimously decided at the meeting held on the 18th inst. to recommend at the forthcoming annual meeting that the Right Hon. Sir Eric Geddes be the president for the year 1922–23. The following gentlemen have been added to the list of vice-presidents: Mr. Arthur Balfour, Lord Colwyn, Mr. A. K. Davies, Mr. George Garnett, Colonel R. K. Morcom, Sir Henry White-Smith, Colonel D. B. D. Stewart and Sir George Sutton, Bart.

MODEL EXPERIMENTS ON DESTROYER PROPULSION.*

By HAROLD E. YARROW, C.B.E.

WITH your permission I should like to refer briefly to a particular branch of research work which has been the means of materially increasing the knowledge of the naval architect. I have collected some data of tests made from time to time in experimental tanks, the results of which clearly show the advantages accruing from carefully conducted model experiments. I have not attempted any comprehensive survey of the subject, but rather have selected a few examples in order to illustrate what has been accomplished in connection with high-speed vessels.

Over fifty years ago the late Dr. William Froude carried out his famous experiments with H.M.S. Greyhound, and obtained a ratio between effective horse-power and indicated horse-power. The thoroughness with which his experiments were carried out, and the complete analysis of the results that was given, made them extremely valuable, and naval architects recognise how much they owe to Dr. Froude for his pioneer work in this direction. It will be remembered that from the results of the Greyhound experiments the basis of comparison between the vessel and its model was established.

In the early eighties a torpedo boat 100 ft. in length by 12 ft. 6 in. in breadth, with a displacement of 40 tons, was run at various speeds, and the indicated horse-power at these speeds recorded. The boat was subsequently towed, and the effective horse-power as well as the ratio of effective horse-power to indicated horse-power was obtained for different speeds. Experiments were then conducted in the Admiralty tank, which at that time was situated at Torquay, with a model of this vessel, and it was found that the effective horse-power calculated from the model results came within 3 per cent. of the results obtained when towing the full-sized vessel, showing, even when model experiments were more or less in their infancy, the accuracy that was obtained by early investigators.

Some years later the influence of depth of water on the performance of high-speed vessels received considerable attention, and I briefly referred in my previous address to the effect of depth of water on speed in this type of vessel. I should like again to allude to this question by drawing attention to some tank experiments upon a model of a destroyer 225 ft. in length by 23 ft. 6 in. in breadth, with a displacement of 600 tons on a draught of 7 ft. 9 in. The tank was fitted with a false bottom so that the depth of water could be varied as desired, and the model was run over a range of speeds corresponding to from 11 knots to 33 knots, in six different depths of water equivalent to 20 ft., 30 ft., 45 ft., 60 ft., 90 ft. and 120 ft. for the ship. Careful observations were made of wave formation and variation of trim of the model at different speeds and depths, and the curves of effective horse-power in terms of speed, deduced from the experiments, are shown in Fig. 1. A feature of these curves is the appearance of a hump at certain points on each curve, indicating that the power rapidly increases at certain speeds in conjunction with certain depths of water, and it will be noticed that as the depth of water becomes greater so this abnormal resistance occurs at higher speeds and is less pronounced. Even when running in a depth of water of 120 ft. there is a perceptible hump on the curve, showing increased resistance at that particular point. It will be seen, on further examination of the curves, that after the hump has been passed the effective horse-power is less for a given speed in shallow water than in deeper water. Further experiments proved that to obtain the true performance of a vessel of this particular size at high speeds by eliminating entirely the effect of depth of water, it would be necessary to run her in water of not less than twenty-five times the draught of the hull.

On another occasion a torpedo-boat destroyer of 400 tons displacement was run at different speeds over a carefully selected course having a depth of water of approximately 40 ft., to ascertain the effect of shallow water on speed, and also to compare the results with the data obtained from model experiments. A model of this vessel, tried in a tank in depths corresponding to 30 ft. and 45 ft. for the ship, gave results which are shown by curves 2 and 3, in Fig. 2. The full black line marked 1 indicates the effective horse-power of the destroyer as deduced from her trials. It will be noticed how closely the tank experiments correspond to the performance of the actual vessel.

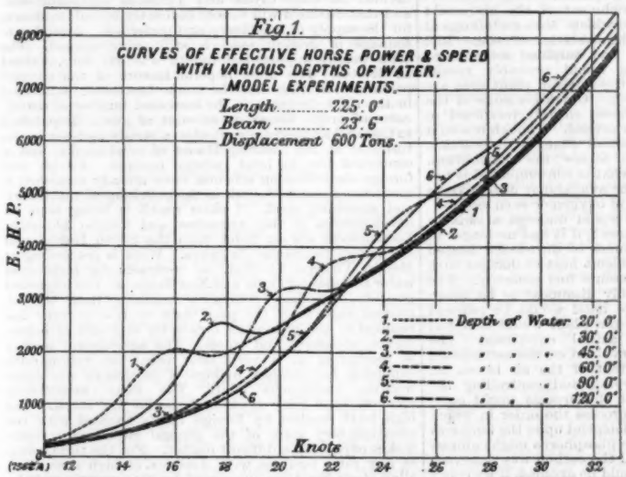
During the trial of this destroyer it was found, when running at a depth of about 40 ft. and the critical speed was being approached (that is, at the point of the curve just where the hump begins) that with a rise of boiler pressure of 25 lb. only half a knot increase in speed was obtained, but when the pressure was increased by another 25 lb. a rise of as much as 5 knots was obtained. The first 25 lb. was required to reach the top of the hump, whereas the next 25 lb. carried the vessel over the hump, and the extra resistance for the increased speed of 5 knots was comparatively small.

When comparing the performance of similar vessels it is clearly necessary that the depth of water over which the trials are made should be definitely ascertained, unless, of course, it is known that the depth is such as not to influence the results. Trials have been made on one day at high water and on another day at low water with entirely different results, although all other conditions remained constant. From the curves in Fig. 2 it will be seen that a difference of 15 ft. in depth of water makes a very considerable difference in power in the region of the humps.

Many interesting and valuable tests have been made by various investigators with a view to reducing the resistance of high-speed vessels to a minimum. A few years ago some experiments were carried out at the tank of the National Physical Laboratory, under the supervision of Mr. Baker, with a model of a destroyer of 255 ft. in length by 25 ft. 7 in. in breadth, to ascertain the effect of parallel middle body on hull resistance. The first series of trials was run at different speeds with the model having no parallel body. The second series was made with a similar model, having parallel body corresponding to 5 ft. for the ship and the bow snubbed a like amount. In the third series, the parallel body and snubbing of the bow corresponded to 10 ft. for the ship in each case. The trials were all made with a constant length, a displacement equivalent to 770 tons, and at speeds corresponding to from 22 knots to 42 knots, for the ship. Fig. 3 represents the comparative curves of effective horse-power required at different speeds as deduced from the model trials. It will be seen that the insertion of parallel body and the anubbing of the bow is undesirable. With 5 ft. of parallel body the effective horse-power is increased by about 6 per cent., and with 10 ft. of parallel body the effective horse-power is increased more than 10 per cent. when running at speeds of about 40 knots. The best model (model A) was selected for a further series of trials to determine the effect of longitudinal trim, the displacement being kept constant and corresponding to 770 tons for the ship. Five conditions of trim were chosen as follow :—

1. With the bow depressed 30 in.
2. With the bow depressed 15 in.
3. On even keel.
4. With the bow elevated 15 in.
5. With the bow elevated 30 in.

Trials at speeds corresponding to 30 knots, 35 knots and



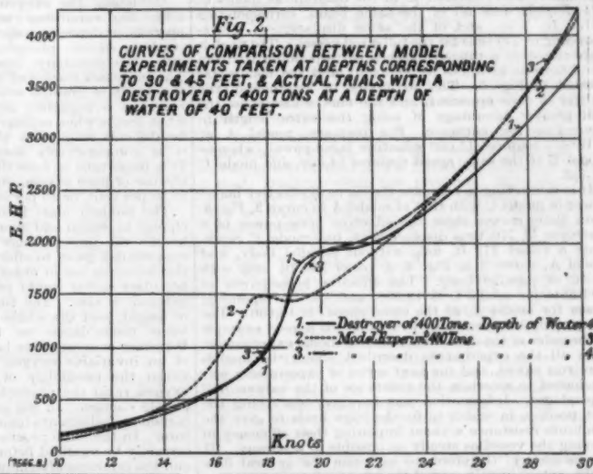


Fig.2.
CURVES OF COMPARISON BETWEEN MODEL EXPERIMENTS TAKEN AT DEPTHS CORRESPONDING TO 30 & 45 FEET, & ACTUAL TRIALS WITH A DESTROYER OF 400 TONS AT A DEPTH OF WATER OF 40 FEET.
E.H.P.
Knots
1 ..... Destroyer of 400 Tons. Depth of Water 40'.0
2 ..... Model Experiments 400 Tons. " " 30'.0
3 ..... " " " " " " 45'.0

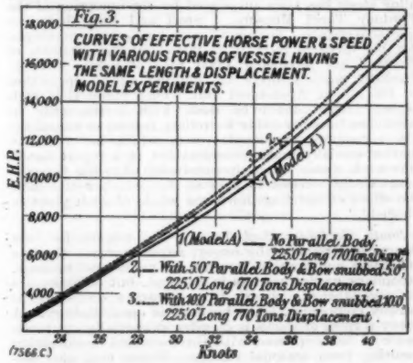
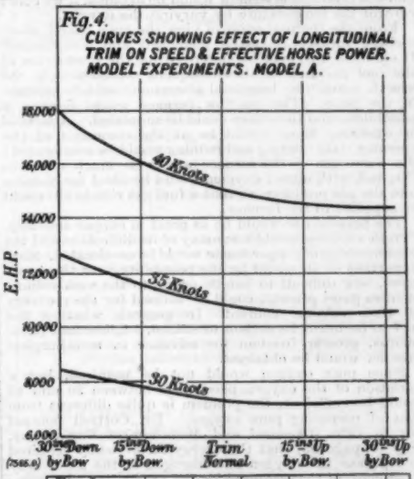


Fig.3.
CURVES OF EFFECTIVE HORSE POWER & SPEED WITH VARIOUS FORMS OF VESSEL HAVING THE SAME LENGTH & DISPLACEMENT.
MODEL EXPERIMENTS.
E.H.P.
Knots
1 (Model A) ..... No Parallel Body. 225.0 Long 770 Tons Displt.
2 ..... With 5.0 Parallel Body & Bow snubbed 5.0. 225.0 Long 770 Tons Displacement.
3 ..... With 10.0 Parallel Body & Bow snubbed 10.0. 225.0 Long 770 Tons Displacement.



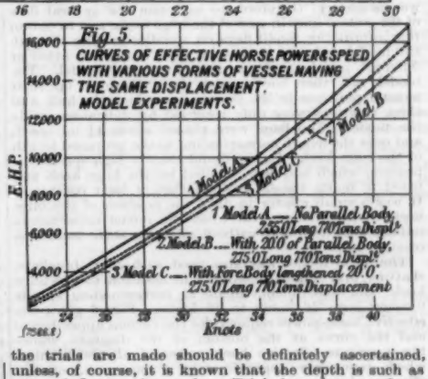
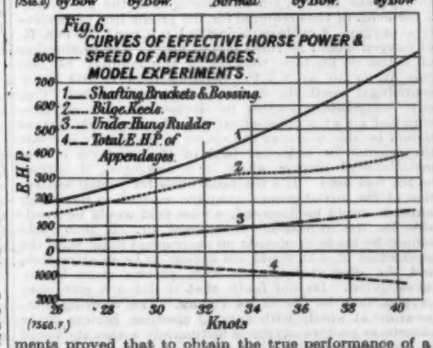


Fig.5.
CURVES OF EFFECTIVE HORSE POWER & SPEED WITH VARIOUS FORMS OF VESSEL HAVING THE SAME DISPLACEMENT.
MODEL EXPERIMENTS.
E.H.P.
Knots
1 Model A
2 Model B
Model C
1 Model A ..... No Parallel Body. 225.0 Long 770 Tons Displt.
2 Model B ..... With 20.0 of Parallel Body. 225.0 Long 770 Tons Displt.
3 Model C ..... With Fore Body lengthened. 20.0'. 225.0 Long 770 Tons Displacement



* Presidential Address delivered to the Institution of Engineers and Shipbuilders in Scotland, October 24, 1922. [Abbreviated.]

40 knots for the ship were run with each condition of trim, and the results shown in Fig. 4 indicate for a moderate trim by the stern a saving in effective horse-power of from 3 per cent. to 5 per cent. according to the speed, as compared to the even keel condition. Excessive trim by the stern, although possibly giving better sea-going conditions, caused increased wave-making and eddy-making at the stern. Trimming by the bow at high speeds caused a large wave, which, in some cases, rose up to the level of the forecastle deck of the vessel. From these results the best trim on which to run this particular design of destroyer was ascertained.

Another series of trials was made with model A as a basis by, firstly, inserting 20 ft. of parallel body in the design so that the length was increased from 255 ft. to 275 ft., referred to in the diagram as model B; and secondly, instead of adding 20 ft. of parallel body to model A, the same length was utilised in elongating the entrance, and is referred to in the diagram as model C. The models were all of the same beam, corresponding to 25 ft. 7 in., and of the same displacement, corresponding to 770 tons for the full-sized vessel. The models were run over a range of speeds corresponding to from 22 knots to 42 knots for the ship, and the results are plotted in Fig. 5. The advantage of lengthening the hull is at once apparent, and the curves also show the still greater advantage of using the extra length in elongating the entrance. For instance, model A at 40 knots requires 15,600 effective horse-power, whereas model B at the same speed requires 14,300, and model C 13,500.

It is interesting to compare the curve of effective horse-power of model C with that of model A in curve 3, Fig. 3. Both these curves show the effective horse-power of a destroyer of 770 tons displacement, but model C represents a vessel 275 ft. long without parallel body, and model A, curve 3 in Fig. 3, a vessel 255 ft. long with 10 ft. of parallel body. The effective horse-power at 40 knots for model C is 13,500, and the corresponding power for model A, at the same speed, is 16,600. The comparison between these two models is a good example of the value of the data obtained from model experiments.

In all the experiments described above the models were run naked, and the next series of experiments was conducted to ascertain the resistance of the various hull appendages. Information was required concerning the best position in which to fit the bilge keels to give the minimum resistance without impairing their efficiency in keeping the vessel as steady as possible in a seaway. It was necessary, therefore, to ascertain the general flow of the stream lines in way of the bilge keels, and to obtain this information small flags on spindles passing through the model and free to turn on their axes were fitted at different positions along the side of the model. The model was then towed, and the flags took up their natural positions in the stream lines along the hull, and these positions were duly recorded by indicators inside the model. The flags were placed about 1¼ in. apart, and over the length corresponding to the proposed length of the bilge keel. It was found that at high speeds the position which had been selected for the bilge keels and fitted to many vessels was not that of least resistance. It was a small matter to alter the position of the bilge keels in accordance with what the model experiments indicated as desirable, without affecting their usefulness in other respects.

The same model was also tried with shaft brackets, shafting, and rudder separately in addition to the bilge keels, and experiments made at corresponding speeds varying from 26 knots to 40 knots. Fig. 6 gives the effective horse-power required for the various appendages, and the curve at the bottom of the diagram shows the aggregate effective horse-power of all the fittings, which represents approximately 8 per cent. of the effective horse-power of the naked model at about 40 knots.

By closely investigating the results of the experiments described, information is obtained regarding the direction in which the hull of the vessel and its appendages may be altered to reduce resistance. Even the power saved in an alteration to the position of the bilge keels is worth securing, as any saving in resistance yields a saving in horse-power for the same speed, and consequently a reduction of weight of machinery. Again less weight of vessel requires less horse-power to propel her at the same speed, so that any saving in resistance is far-reaching, and it is interesting to note that in a destroyer of about 255 ft. in length, with a displacement of 770 tons, for every ton weight saved the vessel will be 120 ft. further ahead at the end of each hour when running at high speed.

From a practical or commercial point of view, it is of little use carrying out experiments with models unless the results obtained can be turned to good account and applied to the actual vessels, but even if any proof were wanted the few examples described are sufficient evidence of their value to the ship designer and of how by the expenditure of a comparatively small amount of money on research work, the performance of ships may be materially improved.

The British Cast-Iron Research Association.—The council of this association have appointed Dr. Percy Longmuir director of research. Dr. Longmuir will take up his duties on November 1. The offices of the association are Central House, New-street, Birmingham.

Personal.—Mr. Leonard G. Tate, secretary of the Electrical Contractors Association (Inc.), and other associations, has removed his offices to the Institution of Electrical Engineers' Building, Savoy-street, Victoria Embankment, W.C. 2. The telephone number will be Museum 4088, the telegraphic address, remaining as now, "Nafecta Phone, London."

THE METALLURGICAL ASPECT OF THE PRODUCTION OF COLD.

By Cosmo Johns, Sheffield.*

Metallurgical smelting and refining processes have become standardised to a large extent, and are based on the assumption of the invariableness of the oxygen content of the atmosphere. Until Gayley, not so long ago, demonstrated that the seasonal variations in the aqueous-vapour content of the atmosphere could be controlled, in the air blown into the blast furnace, by refrigeration, it had been assumed that the moisture content of the atmosphere was beyond human control in metallurgical operations on a commercial scale. To-day the assumption of invariability in the oxygen ratio in the air used is firmly rooted in the minds of those who are operating metallurgical plants.

Obviously the oxygen enrichment of the air would alter the conditions under which the metallurgical operations depending upon the oxidation of some fuel (carbon, silicon, phosphorus and sulphur) are carried out. Revolutionary changes would probably result. The processes employed and the types of plant used are the result of gradual evolution. Our knowledge of the reactions is imperfect and almost entirely restricted to what occurs when ordinary air is used. Though it would be difficult to predict the actual changes in practice, it is comparatively easy to review the possibilities. It is important to note that what is contemplated is not the use of pure oxygen, but the availability of a mixture of 30 per cent. or 40 per cent. of oxygen or even less.

The modern blast furnace would undergo a striking change in design and arrangement, if it had no longer to handle the present huge volumes of dust-laden heated combustible gases to effect difficult heat exchanges with the incoming air in order to secure fuel economy. The hot-blast stoves would probably disappear or be much reduced in size. The furnace itself would be reduced in height, and the whole pig-iron plant would bear but little resemblance to the actual equipment. The Bessemer converter has been evolved on the assumption of an invariable oxygen content of the air blown in. Given the possibility of varying and controlling the oxygen ratio the character of the process would completely change. In the acid process the order in which carbon and silicon are removed depend upon the temperature. In the basic process the phosphorus might almost certainly be oxidised before all the carbon was removed, and the injurious afterblow would be avoided, if we could control the temperature by varying the oxygen.

From the thermal point of view the open hearth steel-melting furnace is costly, inefficient and complicated. If enriched air could be employed for the production of the fuel gas and for its subsequent combustion in the hearth, a startling beneficial alteration could be effected in the plant. The uni-flow furnace would become a possibility, and the design could be simplified. A neutral or oxidising flame would be at the command of the operator; the melting and refining would be accelerated; the waste gas of the furnace would be much richer in CO_2 and, with added oxygen, would be ideal for blowing into the gas producer, so that a fuel gas rich in CO could be supplied to the furnace.

The possibilities would be as great in copper smelting. Pyretic smelting would lose many of its difficulties and the bessemerising of copper matte would be accelerated. Most important of all would be the possibility that the waste gases, now difficult to handle owing to the vast volume of inert gases present, could be utilised for the recovery of their sulphur content. In general, whether the fuel to be burnt be carbon or silicon, sulphur and phosphorus, greater freedom for advance in metallurgical practice would be obtained.

Since pure oxygen would not be required, but a variation of the oxygen percentage between 20 and 40 would be sufficient, the problem is quite different from that of preparing pure oxygen. Dr. Cottrell pointed out in 1920 (*Chemical and Metallurgical Engineering*, July 14, page 53) that the energy theoretically required to separate the oxygen and nitrogen of the air is only 1 per cent. of that required for the production of electrolytic oxygen. A cycle requiring 30 h.p.h. per 1,000 cub. ft. of oxygen would be ruled out at once. The production of 1 ton of pig-iron requires in this country 140,000 cub. ft. of air at N.T.P. Separation of O and N by centrifugal methods does not appear hopeful. Can any refrigerating system be devised to give oxygen-enriched air at a commercial price? Any such system should be able to use as the source of the energy it needs the sensible or potential heat of the products of the metallurgical process where it is employed, if carbon be the fuel used. If a reactable cycle for partial separation of the mixed gases—complete separation not being wanted—could be disclosed, a vast field would be available for the utilisation of enriched air. If that cycle cannot be made to operate on economical lines, then the production of cold would not appear to be so attractive, and the discarded barium-oxide process must be re-investigated. Its old fault, that it did not give pure oxygen, may be one of its virtues. The working temperature at which, with varying pressure, barium oxide absorbs or evolves oxygen is fortunately within the range of the now available impermeable alloys which resist oxidation.

The temperature required can be supplied by the sensible or potential heat of the waste gases in many metallurgical operations. If refrigeration fail as a method of giving enriched air, then substances of similar properties to barium oxide require careful investigation.

* Contribution to the discussion on "The Generation and Utilisation of Cold," held by the Faraday Society and the British Cold Storage and Ice Association, Monday, October 16. Abstract.

NOTES FROM SOUTH YORKSHIRE.

Sheffield, Wednesday.

Iron and Steel.—Despite the improved condition of order books and the marked increase in inquiries for practically all classes of steel and engineering products, the large majority of manufacturing concerns are barely covering current expenses. Maintenance of idle plant in an efficient condition in readiness for revival alone constitutes a heavy burden. At the same time confidence is shown in the ability of local industry to weather the depression. The basis of steel output is still being widened, special attention being given to the rolling and forging of alloy steels. The placing of contracts for the two new battleships sanctioned under the Washington Conference Agreement is awaited with keen local interest. It is expected that the work will be divided between Clyde and Tyneside establishments, and that Sheffield will benefit indirectly by sub-contracts for the supply of machinery and materials. A moderate tonnage of armour steel is still going abroad. The total weight shipped last month was 357 tons, valued at 69,000*l*. The most hopeful feature of the current position indicating that the trade barometer is moving in the right direction is the increased number of certificates of origin issued on account of goods despatched to Colonial and foreign countries, a steady increase in the turnover at the Clearing House of local banks, and a continued rise in local railway receipts. British and foreign electrification schemes have already furnished a moderate amount of work in the provision of machinery and structural steel. A close watch is being kept on developments in the Argentine and Czecho Slovakia. Locomotives are on order from the South Indian and the Indian Peninsular Railways. Work is proceeding at Messrs. Vickers, Limited, on contracts for large-sized water turbines for India and New Zealand. The improved position of colliery companies resulting from the increased exports of the past three or four months has resulted in the placing of orders for renewals of implements, apparatus and stores. The agricultural section is recovering at a very slow rate, but rolling-mills supplying Lincolnshire makers of machinery are again working continuous shifts. The least satisfactory recovery is in alloy steels and special tool steels. The high level reached by foreign tariffs coupled with the unsatisfactory state of the general engineering trade, makes expansion a difficult matter. For the time being, at any rate, business with America in high speed and alloy steels has been suspended by the operation of the Fordney Tariff Measure. Steel and iron shows no quotable change. The chief demand is for basic materials. Six big furnaces recently restarted on the outskirts of Sheffield are producing 4,000 tons of ingots a week. Sheffield manufacturers are offering strong opposition to the Smoke Abatement Bill. They claim that high carbon steels cannot be dealt with satisfactorily in smokeless furnaces either for rolling, forging or annealing. The committee of manufacturers, which has had the matter specially under consideration, in a report issued this week states "It is inconceivable that the Government would consent to pass an Act which would have the effect of shutting down the whole of such plant in Sheffield."

South Yorkshire Coal Trade.—The market for best steams is dominated by export requirements. German purchases continue to increase in value and tonnage. Secondary grades are less in demand, but collieries are not overstocked. Apart from contract deliveries to railway companies, home business is unsatisfactory. A heavy surplus of slacks is on offer at specially cut rates. Gas coal has improved with the increased consumption resulting from seasonal change. House coal also displays a rather firmer tone. Collieries are well booked forward for the better classes, though inferior grades continue slow. Quotations:—Best branch handpicked, 32*s*. 6*d*. to 34*s*. 6*d*.; Barnsley best Silkstone, 28*s*. to 30*s*.; Derbyshire best brights, 24*s*. to 25*s*.; Derbyshire best house, 21*s*. 6*d*. to 22*s*. 6*d*.; Derbyshire best large nuts, 18*s*. 6*d*. to 20*s*. 6*d*.; Derbyshire best small nuts, 15*s*. to 16*s*. 6*d*.; Yorkshire hards, 20*s*. to 21*s*.; Derbyshire hards, 19*s*. to 20*s*. 6*d*.; rough slacks, 8*s*. 6*d*. to 10*s*. 6*d*.; nutty slacks, 7*s*. 6*d*. to 8*s*. 6*d*.; smalls, 3*s*. to 5*s*.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

Middlesbrough, Wednesday.

The Cleveland Iron Trade.—Producers of Cleveland pig-iron are well sold, chiefly to America, and buying for the United States continues, but home demand is only moderate, and Continental inquiries are few, the comparatively cheaper iron of other districts capturing markets that have hitherto drawn most of their supplies from here. Forge quality is fairly plentiful, but all other grades of Cleveland pig-iron are still very scarce and difficult to purchase to any extent for early delivery. There is likelihood of one or two more idle furnaces being re-started. Quotations stand:—No. 1 and siliceous iron, 97*s*. 6*d*.; No. 3 G.M.B., 92*s*. 6*d*.; No. 4 foundry, 90*s*.; and No. 4 forge, 85*s*.—all f.o.t. makers' works or f.o.b. Tees.

Hematite.—The considerably improved statistical situation has strengthened the hand of East Coast hematite makers. Stocks have been a good deal drawn upon, and some producers have not only no iron on hand, but have disposed of their output a few weeks ahead. Other firms are not so fortunately placed, and they offer Nos. 1, 2 and 3 at 92*s*. 6*d*. for home purposes, or for shipment overseas No. 1 is put at 93*s*.

Foreign Ore.—Sellers of foreign ore are keen to secure orders, but the price concessions they are prepared to make fail to tempt consumers, several of whom are still

carrying considerable stocks, and have fairly good supplies yet to come forward against contracts made. It is understood that business could be put through on the basis of 22*s.* 9*d.* c.i.f. Tees for best rubio.

Blast-Furnace Coke.—Values of Durham blast-furnace coke keep on a high level, but local users refuse to pay the figures named, and firms having to purchase report they are able to obtain supplies at a good deal below the recognised market quotation of 31*s.* for average qualities delivered, sellers being prepared to meet old customers.

Manufactured Iron and Steel.—There is a distinctly better feeling in manufactured iron and steel, but there is still vast room for improvement. However, a few steel orders have been secured, and a little more plant is in operation. Export business can be put through at below the following quotations which rule for local delivery :—Common iron bars, 10*l.* 10*s.* ; iron rivets, 11*l.* ; steel bars, 9*l.* ; steel billets (soft), 7*l.* 10*s.* ; steel billets (medium), 8*l.* ; steel billets (hard), 8*l.* 5*s.* ; steel boiler plates, 12*l.* 10*s.* ; steel ship, bridge and tank plates, 9*l.* to 9*l.* 10*s.* ; steel angles, 8*l.* 15*s.* ; steel joists, 9*l.* 10*s.* ; tees, 10*l.* ; heavy sections of steel rails, 9*l.* ; fish plates, 14*l.* 10*s.* ; black sheets, 12*l.* ; and galvanised corrugated sheets (No. 24 gauge, in bundles), 16*l.* 10*s.* The cost of conveyance is added to the foregoing quotations for home delivery to customers at a distance.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Scottish Steel Trade.—The past week has again been one of some anxiety to the Scottish steel makers because of the small number of contracts being placed. Day-to-day orders are all too common, and this position will continue until the parliamentary elections are over, after which it is hoped that the present want of confidence on the part of consumers will pass away and more stable conditions come into being. The prospect of the placing of an order for a new battleship on the Clyde has created a decidedly good feeling, and with the fixing of occasional contracts by the local shipbuilders—one last week and another this week—the outlook for ship plates, &c., is certainly getting a little better. The mills, however, are still moving very slowly, and structural sections are in poor demand. Makers of black sheets are beginning to find things rather stiff, as there has been a slackening in the export demand for the thinner gauges, while there is little business going through for the heavier sheets. The shipping trade generally is far from satisfactory. Prices show little or no change, and the following are the current quotations :—Boiler plates, 12*l.* 10*s.* per ton ; ship plates, 9*l.* per ton ; sections, 8*l.* 15*s.* per ton ; and sheets, ¼ in., 10*l.* 5*s.* per ton, all delivered Glasgow

Malleable Iron Trade.—There has been no sign of any improvement in the malleable iron trade of the West of Scotland since last report and the position is not very reassuring. The home demand is of a very limited nature and inquiries are poor, while there is extremely little being done on export account. No change has been made in prices, and "crown" bars are quoted at 10*l.* 10*s.* per ton, delivered Glasgow.

Scottish Pig-Iron Trade.—A fairly steady tone continues in the Scottish pig-iron trade, but home prices are inclined to be less firm. Foreign shipping is still the mainstay of the industry and the returns are very satisfactory. On the other hand there is a decided lack of demand from home consumers, and as general trade is very quiet still the prospect of a local buying movement seems still rather far off. Hematite iron is in poor demand. The following are to-day's prices :—Hematite, 5*l.* 7*s.* 6*d.* per ton, delivered at the steel works ; foundry iron, No. 1, 5*l.* 5*s.* per ton ; and No. 3, 5*l.* per ton, both on trucks at makers' yards. During the week ending last Saturday, October 21, the shipments from Glasgow harbour totalled 7,844 tons, all of which, except some 73 tons, went foreign. For the corresponding week last year the shipments were only 174 tons. The total amount shipped up to date this year is now 74,259 tons—67,375 tons abroad and 6,884 tons coastwise.

Shipbuilding.—Contracts recently placed with Clyde shipbuilders include the following : One vessel of approximately 7,500 tons to be built by Messrs. Scotts' Shipbuilding and Engineering Company, Limited, Greenock ; one vessel for the Clyde Shipping Company, Glasgow, to be built by Messrs. Alexander Stephen and Sons, Linthouse, Govan. This steamer will be of 1,560 tons gross, and 270 ft. long, and is for the general carrying trade of the owners.

NOTES FROM THE SOUTH-WEST.

CARDIFF, Wednesday.

The Coal Trade.—The threatened general strike of coal miners in South Wales over the non-unionist question which was to have taken place on November 1, has to all intents and purposes been abandoned. At many collieries the men have flatly refused to hand in their notices, and it is expected that a delegate meeting will soon be held to consider the position. It is, however significant that the dispute at Ebbw Vale has been settled and that the pits, which employ some 5,000 men, are to be re-started on Monday. It is a fortnight ago since an agreement was reached between the men's representatives and the company, but the latter refused to re-start the pits in view of the threatened non-unionist strike. That obstacle has now been removed. Generally the coal market has developed a stronger tone. This is especially the case in regard to the better qualities of large coals which are fully sold for this month, and in some cases also over November. Of late comparatively small orders have been coming in from the Continent for cargoes, and in the aggregate these amount to a substantial quantity, while Italy and South America, too, have been buying freely during the last couple of weeks. Best Admiralty large is now firm at 17*s.* 6*d.* to 28*s.* 6*d.*, with Monmouthshire round 25*s.* 6*d.* and dry large 28*s.* to 29*s.* Smalls, however, are still erratic, though not so plentiful as was the case a week ago. The best steams command about 16*s.* to 16*s.* 6*d.*, with other grades in proportion. Anthracite descriptions continue steady, with Big Vein large at 60*s.* and French and stove nuts at 72*s.* 6*d.* Exports of coal as cargo from South Wales last week were diminished largely as a result of stormy weather and the non-arrival of expected tonnage and consequent dislocation in loading operatings. In all 394,733 tons of coal were exported of which 120,409 tons went to France, 74,759 tons to Italy and 38,577 tons to South America. Shipments to the United States and Canada amounted to 27,437 tons, of which 20,637 tons went to the States and 6,900 tons to Canada. In all 1,426,013 tons of Welsh coal have now been shipped across the Atlantic and something like another 350,000 tons are still to be lifted.

Shipping Company Failure.—Shareholders in the Westville Shipping Company, Limited, Cardiff, have received a notice calling an extraordinary meeting to pass the following resolution : "That it has been proved to the satisfaction of the company, that the company cannot by reason of its liabilities, continue its business, and that it is advisable to wind up the same, and accordingly that the company be wound up voluntarily in accordance with the Companies' Acts, 1908 to 1917, and that Mr. Clifford Henry Longdon Griffiths, A.C.A., of Merchants Exchange, Cardiff, chartered accountant, being the nominee of the bank, be appointed liquidator for the purpose of such winding up." The balance sheet shows that the liability to the bankers is 96,386*l.*, and that a loss of 31,093*l.* was sustained in the past two years. The company owned three steamers aggregating 2,340 tons deadweight, which cost 148,400*l.* The chairman of the Board of Directors was Sir John Daniel, Cardiff.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.—This Institution has issued a programme for the thirty-ninth session, 1922–23. The first meeting for the reading and discussion of papers is being held to-day, when Mr. W. Dinwoodie will contribute a paper on "Wave Transmission of Power." Other meetings will follow regularly at fortnightly intervals until April 20, 1923. The meetings are held at Bolbec Hall, Newcastle-upon-Tyne.

THE FRENCH AERONAUTICAL SOCIETY.—The Société Française de Navigation Aerienne has issued the programme of its meetings for the session 1922–23. The first meeting was held on the 18th inst., when Dr. Magnan read a paper on gliding, and Mr. Drôsne a paper on the laws of air resistance. Other papers are announced to be read at regular intervals, to June 20. The meetings are held at 9 p.m. in the hall of the Société des Ingénieurs Civils, 19, Rue Blanche, Paris.

THE ASSOCIATION OF MANUFACTURERS OF NON-CORRODIBLE AND ANTI-CORROSIVE PRODUCTS.—Arrangements have been made for the preliminary meeting of this association, to be held on Tuesday, the 31st inst., at 2.30 p.m., at Room 1, Caxton Hall, Victoria-street, S.W. 1. The organiser, Mr. W. R. Douglas Shaw, will be available in the interim on weekdays between 11 a.m. and 1.30 p.m., at the temporary offices, 84, Baker-street, W. 1. Further information may be obtained from him at these offices.

THE INSTITUTION OF MECHANICAL ENGINEERS' CONVERSAZIONE.—The conversazione of the Institution of Mechanical Engineers this year marked a departure from previous custom. In the first place in order to avoid the rather unpleasant overcrowding which has been experienced at the Institution's functions of this character, the conversazione held on October 19, of this year, took place at the Hotel Cecil, Strand, W.C. 2. The guests were received by the President, and Mrs. Hele-Shaw, and council, and the feature of the evening was a dance which was much enjoyed by those present. Between three and four hundred members and friends were present during the evening, and the whole event was considered eminently successful, and a pleasant change from the functions previously held at the Institution in Storey's Gate.

THE RUDGE-WHITWORTH RESEARCH LABORATORIES.—The research laboratories of the Rudge-Whitworth Company, Limited, of Coventry and Birmingham, have now been established for twenty-one years, and to mark the event the company has issued a booklet describing the chief activities of the laboratories. These have been referred to more than once in our columns. It is interesting to note that the laboratory department is now on a commercial footing, and does more than support itself by the revenue which it earns. Its chief sources of revenue are the production of gauges of various kinds, micrometer appliances, case-hardening compounds, optical pyrometers, rust-proofing processes, portable Brinell testing appliances, workshop microscopes, &c. All these were developed in the first place to meet the needs of the company, but have been put on the market for the benefit of other manufacturers. Ever since the department was established in 1901 it has been in charge of Mr. H. L. Heathcote, B.Sc.(Lond.), M.Sc. (Birmingham), F.I.C., to whose ability its success is very largely due.

NOTICES OF MEETINGS.

THE INSTITUTION OF MECHANICAL ENGINEERS.—Friday, October 27, at 6 p.m., at Storey's Gate, St. James' Park, S.W. 1. Adjourned discussion on "The Use of the Turbo-Compressor for Attaining the Greatest Speeds in Aviation," by Professor Auguste Rateau. Friday, November 3, at 6 p.m., Lecture on "Repairs to the Roof of Westminster Hall," by Sir Frank Baines, C.B.E., M.V.O.

THE INSTITUTE OF METALS : NORTH-EAST COAST SECTION.—Friday, October 27, at 7.30 p.m., in the Electrical Engineering Lecture Theatre, Armstrong College, Newcastle-on-Tyne. Paper on "The Production of Large Metallic Crystals and Some of their Properties," by Professor H. C. H. Carpenter, F.R.S.

THE JUNIOR INSTITUTION OF ENGINEERS.—Friday, October 27, at 7.30 p.m., at 39, Victoria-street. Question and General Discussion Evening.

THE INSTITUTION OF CIVIL ENGINEERS : YORKSHIRE ASSOCIATION.—Friday, October 27, at 7.30 at p.m., the Philosophical Hall, Leeds. Presidential Address by Lieutenant-Colonel M. M. Bidder, D.S.O., M.Inst.C.E. Discussion of future policy of the association will take place afterwards.

THE STAFFORDSHIRE IRON AND STEEL INSTITUTE.—Saturday, October 28, the Opening Meeting of the Session will be held at the Education Offices, St. James'-road, Dudley, when the president, Mr. Jos. Payton, will give a short address to be followed by an address by the vice-president, Mr. F. J. Cook, on his American experiences in connection with the Iron and Steel Industries. Chair to be taken at 7.15 p.m.

THE BRADFORD ENGINEERING SOCIETY.—Monday, October 30, at 7.30 p.m., in the Hall of the Bradford Technical College. Lecture by Mr. A. J. H. Elverson, on "The Oscilloscope and its Application."

THE INSTITUTION OF RAILWAY SIGNAL ENGINEERS (INCORPORATED).—Wednesday, November 1, at 3 p.m., at the Institution of Electrical Engineers, Victoria Embankment, W.C. 2. Resumed discussion of Mr. T. S. Lascelles' paper on "Weissenbruch's Signal System on the Belgian State Railways." The reading of Mr. J. Holt's paper on "A Few Remarks on Railway Accidents" is postponed.

THE INSTITUTION OF LOCOMOTIVE ENGINEERS : SCOTTISH CENTRE.—Thursday, November 2, at 7.30 p.m., in the Societies' Room, Royal Technical College, George-street, Glasgow. Opening Meeting of the Session. Address by Mr. Walter Chalmers, Chief Mechanical Engineer, North British Railway Company.

THE INSTITUTION OF ELECTRICAL ENGINEERS.—Thursday, November 2, at 6 p.m. Inaugural Address by Mr. Frank Gill, president. Presentation of premiums.

NORTHAMPTON ENGINEERING COLLEGE ENGINEERING SOCIETY, LONDON.—Thursday, November 2, at 5.30 p.m. A paper on "Floating Docks" will be read by Mr. Grixoni. The chair will be taken by Mr. C. E. Larard, M.Inst.C.E., M.I.Mech.E.

THE ASSOCIATION OF ENGINEERING AND SHIPBUILDING DRAUGHTSMEN.—Friday, November 3, at 7 p.m., in the Memorial Hall, Farringdon-street, E.C. Address on "Adult Education," by Lord Haldane.

THE JUNIOR INSTITUTION OF ENGINEERS.—Friday, November 3, at 7.30 p.m., at 39, Victoria-street. Lecturette, "Laminated Springs," by Mr. T. H. Sanders, M.I.Mech.E.

WEST YORKSHIRE METALLURGICAL SOCIETY.—This society has issued its programme of meetings for the winter session. The meetings are to be held in Huddersfield, Halifax, Bradford and Leeds, commencing to-morrow, the 28th inst. The papers will deal both with ferrous and non-ferrous metals.

BELLS OF SIEMENS-MARTIN STEEL.—Most of the church bells having been melted down in Austria and Germany during the war, the question now is how to replace them by less expensive products. According to J. Hruska, Pribram, Bohemia (*Stahl und Eisen*), bells of cast Siemens-Martin steel give practically the same tone as the old bells of the same size and are much lighter in weight, whilst crucible steel bells, which were first tried, give relatively higher tones. As regards purity of tone, crucible steel is undoubtedly preferable to open-hearth steel. Decorations on the bells should be avoided, as they interfere with the ease of casting and with the purity of the note. The moulds should be coated inside twice, and the rough casting turned true and then made rustproof in some way, which he regrets not to be able to explain.

FERRO-CONCRETE BOATS.—A recent report on the experience gained with ferro-concrete boats on German canals, is unfavourable, though they were found superior to most canal barges in one respect, *i.e.*, as regards the resistance to motion. On the Ems-Weser Canal ferro-concrete boats about 200 ft. in length with nearly 30 ft. beam and about 6½ ft. draught, carrying about 750 tons, were more easily towed than the ordinary barges coming from the Rhine, Weser and Elbe ; the decrease in resistance in fact rose nearly to 50 per cent. in some cases, although the concrete boat as such is heavier than the common barge. The chief trouble was that the boats would not stand either the rough shocks, to which canal towage exposes them, nor the winter frosts. The lesser resistance was chiefly ascribed to the more scientific lines of the boats, a feature to which more attention will now be paid in barge construction.

LOCOMOTIVE COALING PLANT AT CREWE; LONDON AND NORTH-WESTERN RAILWAY.

CONSTRUCTED BY THE MITCHELL CONVEYOR AND TRANSPORTER COMPANY, LIMITED, ENGINEERS, LONDON.

(*For Description, see Page* 511.)

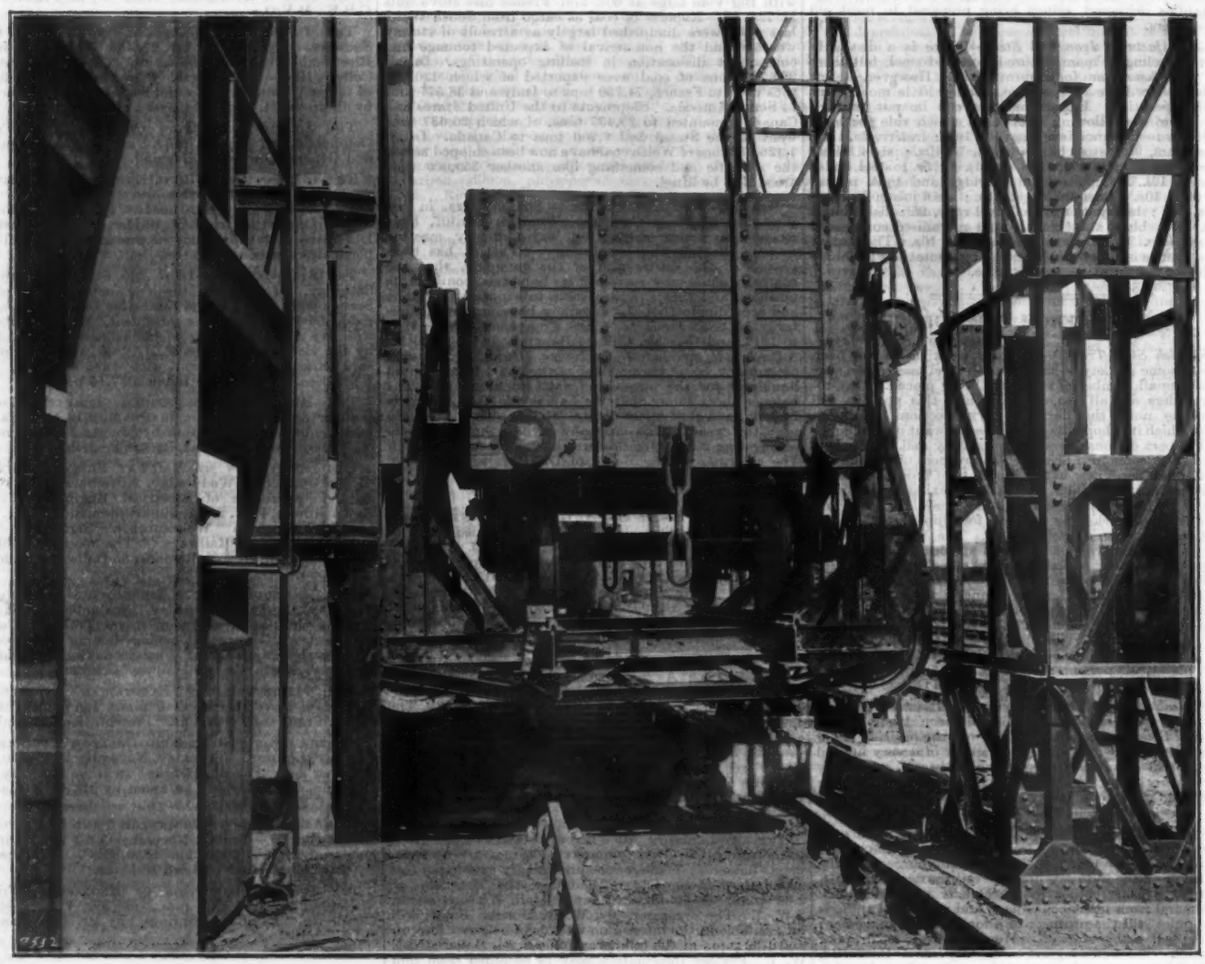


Fig. 39. Cradle Loaded with Wagon at the Commencement of the Hoist.

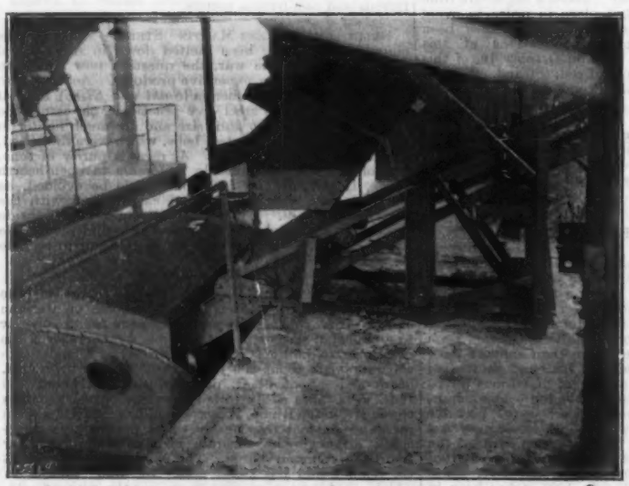


Fig. 40. Tank Locomotive being Coaled.

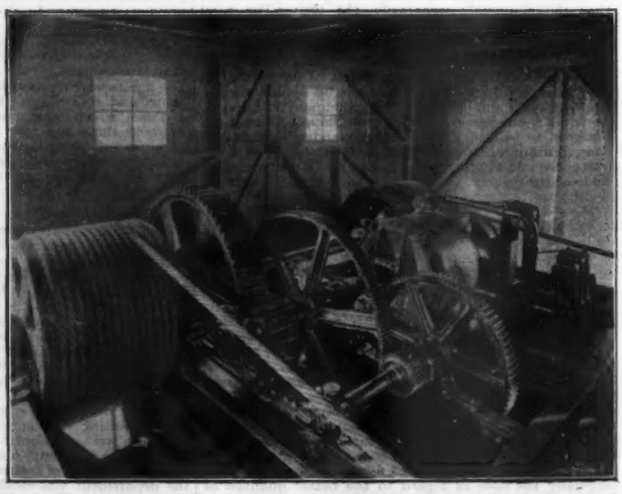


Fig. 41. Interior of the Winch Room.

LOCOMOTIVE COALING PLANT AT CREWE, LO

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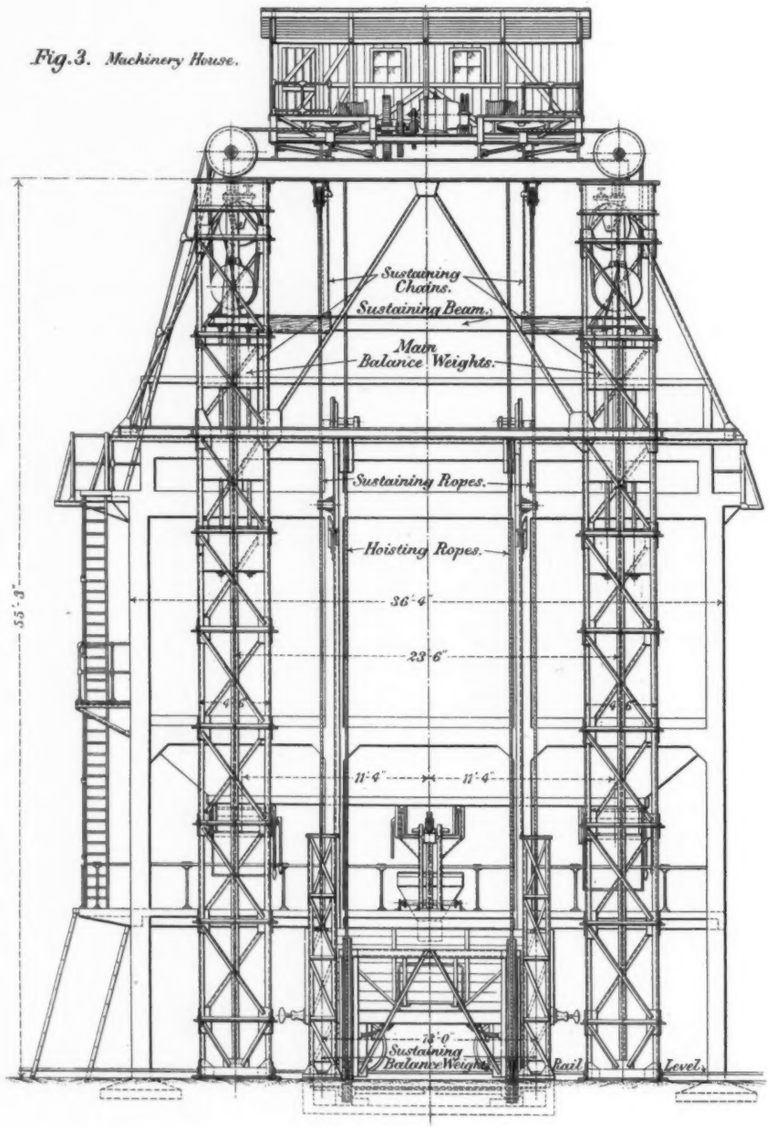


Fig. 3. Machinery House.

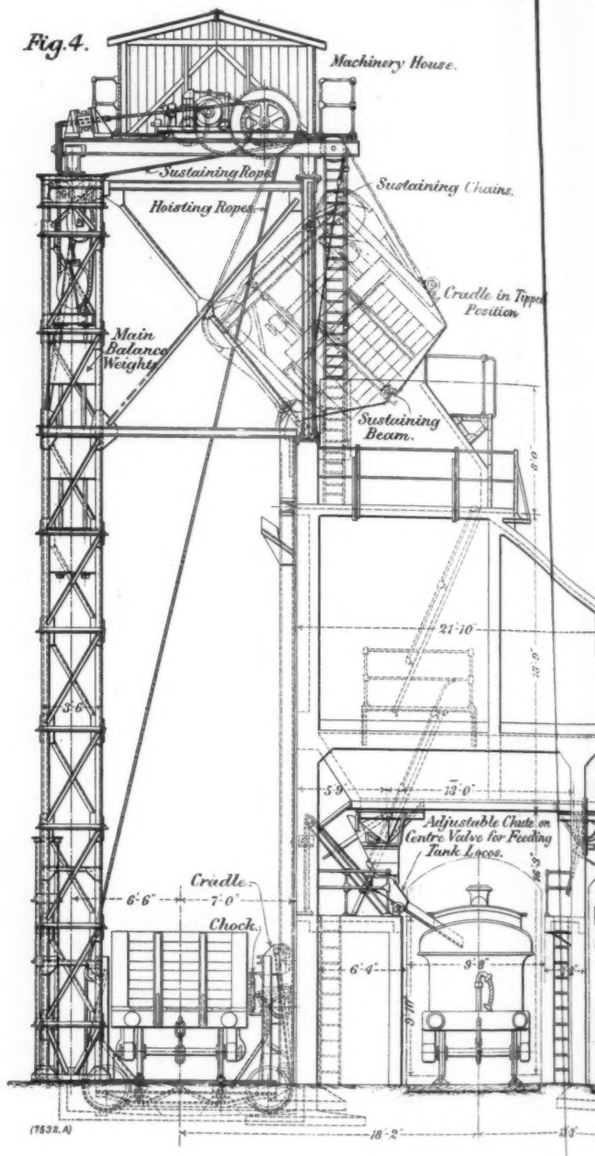


Fig. 4.

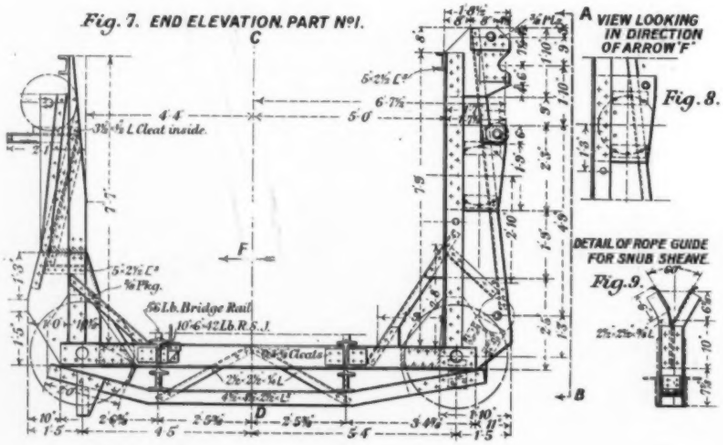


Fig. 7. END ELEVATION. PART No. I.

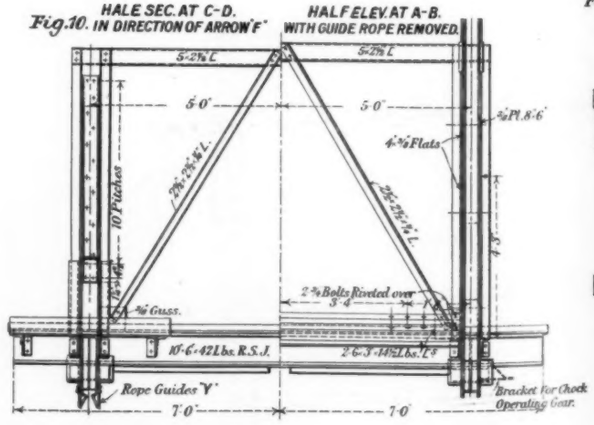


Fig. 10.

WE, LONDON AND NORTH-WESTERN RAILWAY.

AND TRANSPORTER COMPANY, LIMITED, ENGINEERS, LONDON.

(scription, see Page 511.)

Fig. 6.

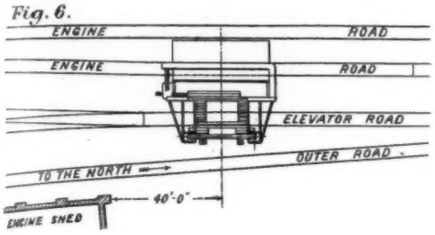
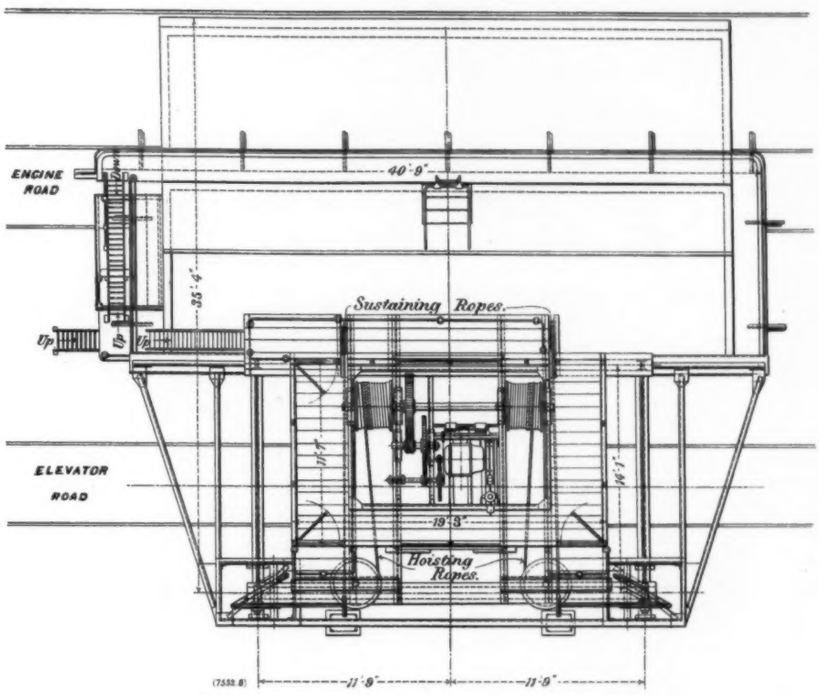
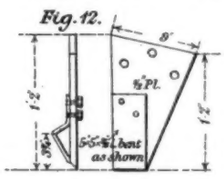


Fig. 5. PLAN



DETAIL OF ROPE GUIDES "Y"

Fig. 12.



Ferro-Concrete Bunker.

Chute on Feeding

Fig. 13.
DETAIL OF CRADLE FORKS.

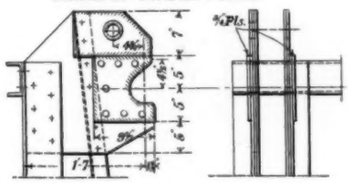


Fig. 17.

Fig. 18.

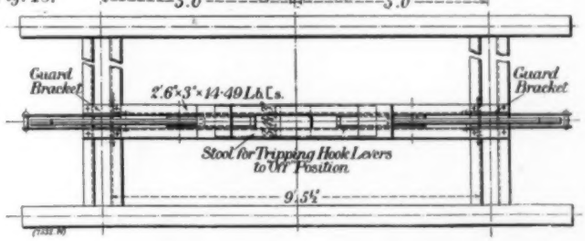


Fig. 9. PLAN WITH L.H. ROPE GUIDE REMOVED.

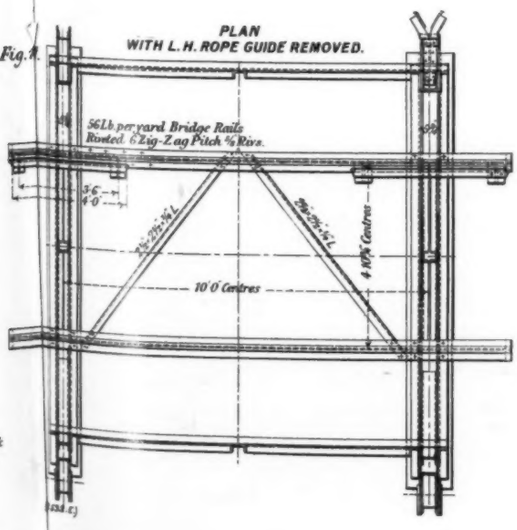


Fig. 14.
SEC. C-D.

Fig. 15. ELEVATION OF CHOCK. PART No 2.

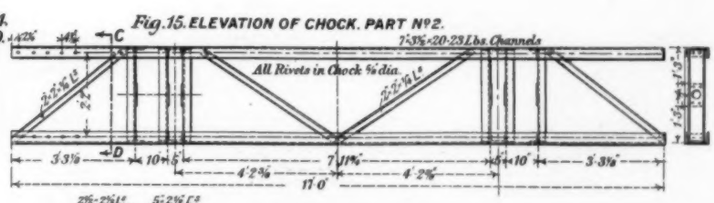
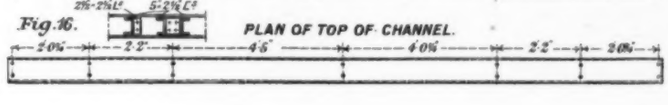


Fig. 16.



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ENGINEERING.

FRIDAY, OCTOBER 27, 1922.

THE ACTIVITIES OF THE INSTITUTION OF MECHANICAL ENGINEERS.

THE Institution of Mechanical Engineers is now seventy-five years old, and during the whole of this period it has played a predominant *rôle* in the advancement of mechanical engineering in this country. We hear to-day much—indeed, from some quarters, almost too much—as to the importance of research, and the younger generation is apt to believe that the recognition of this need is relatively recent. Nevertheless, as is pointed out in the able and interesting presidential address of Prof. Hele-Shaw, of which we publish a full abstract on page 538, the Institution of Mechanical Engineers realised as far back as 1879, the eminent desirability of systematic experimental investigation of certain problems then confronting the engineer.

Three were specially prominent at the time. Thus the growing use of steel had brought home to the boiler-maker and shipbuilder the fact that he knew relatively very little as to the physical and mechanical properties of the new material. Many firms, of course, were devising rough and ready experiments of their own, but it was very evident that much more was needed, and the Institution decided accordingly to step into the breach and appointed a committee to carry through the proposed investigation. At the same time it was felt that much still required to be learnt as to the strength of riveted joints, the more especially as there was no *a priori* certainty that it would be prudent to treat steel in precisely the same way as wrought iron. A second committee was accordingly constituted to conduct this research, and their reports, which included the compilation of a most able summary of the work of their predecessors, added new experimental data of the utmost value. This report has largely governed subsequent practice both here and abroad.

Still a third problem was urgent at the time. The then recent introduction of the dynamo had given rise to a demand for speeds of rotation in excess of all ordinary experience in the construction of heavy machinery, and a third committee was accordingly appointed to investigate the subject of frictional resistances at high speeds. This third research culminated in the experiments of Beauchamp Tower, which, highly instructive as they were in themselves, have become classic, since they constituted the basis on which Osborne Reynolds founded his epoch-marking work on the theory of lubrication, which, as further developed by Mr. Michell, alone made practicable the construction of the Hood, in which some 36,000 h.p. are transmitted through a single propeller shaft. To take this power, a thrust block of the ordinary type would have been of the impossible length of some 20 ft. to 25 ft. We do not recall the exact cost to the Institution of this investigation into journal friction, but as one of its ultimate results, the Admiralty have admitted a saving during the war years of something like 500,000*l.* in the cost of lubricating oil. This one research, therefore, would very much more than justify the total expenditure of the Institution on research during the last sixty years, which has, it appears, amounted to between 13,000*l.* and 14,000*l.* The precedent set in 1879 has been consistently followed since, and we thus owe to the Institution much of our knowledge of the properties and constitution of alloys.

Another interesting research organised by the Institution had to do with the efficiency of marine engines as to which the vaguest ideas prevailed, and concerning which many extravagant claims were made. In the early days of the triple-expansion engine, for example, builders quite frequently recorded coal consumptions of 1½ lb. to 1¼ lb. of coal per i.h.p. hour, and the coal used was, moreover, far from being of exceptional quality.

More recently the Institution arranged for an inquiry into the efficiency of the nozzles and guide blades used in steam turbines. The necessity for this was very patent at the time, as two very serious anomalies required explanation. In the first place, many careful observers had recorded discharges in excess of the theoretical, and, in the second, the experiments on nozzle efficiencies made at Charlottenburg led to conclusions in flat contradiction to actual practical experience. Fortunately, it was found possible to clear up the first of these anomalies without further experimental data, but the obvious unreliability of the Charlottenburg tests showed the need for further research with improved apparatus. A committee was accordingly appointed to pursue this investigation, but, unfortunately, the war not only greatly delayed the commencement of the experiments, but has added most seriously to the cost. It is hoped, nevertheless, that this will prove to be justified by the very high degree of precision attained, and the accord established between experiment, experience and theory.

At the outset the decision of the Institution to engage in research met with some slight opposition, originating in part, perhaps, with those who, having had the courage and enterprise to take up the new processes and manufactures, had acquired much useful experience, the commercial value of which was threatened to be discounted by the investigations of the various Research Committees. To-day the suggestion is again made that the policy of subsidising research should be abandoned, particularly in view of the fact that there are now a number of institutions specially devoted to research work. No doubt these will be quite capable of dealing adequately with many investigations akin to those previously financed by the Institution, but this is not likely to prove true in all cases, though the mere work of measurement might no doubt often be left them, even in cases where it might well be advisable for the Institution to fix by a committee the character and scope of the experiments to be made.

At the same time that the Institution was inaugurating research schemes, it was giving hearty support to plans for improving the technical education of the rising generation of engineers. Since 1879 technical colleges have multiplied largely and many Universities now give a degree in engineering. The standard demanded varies, however, very considerably, and we have frequently had papers

proffered for publication in Engineering by men, who in spite of their degree, have shown themselves far from well grounded in mechanical principles. In a recent publication an American engineer has called attention to a similar condition of affairs in the United States, where he observes students are being taught to calculate instead of being required to think. It would be excellent if the Institution of Mechanical Engineers could do something towards establishing a more uniform standard of qualification for degrees in engineering. As regards the membership of the Institution itself insistence on a very high standard of theoretical knowledge would be inadvisable, since a man, excellent both as an organiser and a mechanic, may have but the haziest ideas as to the laws of motion, and yet be turning out very sound engineering work along his own special line. Indeed, where experience is ample, theory helps but little, and by the gradual accumulation of experience the mechanical engineer of the past did succeed in constructing excellent steam engines, although he would probably be incapable of securing to-day a pass in an elementary paper on thermodynamics. Although experience is the most effective of teachers, the course is long and the fees high, and whilst, in almost all works, it suffices for the needs of to-day, it frequently affords but little help towards solving the problems of the morrow. A notable instance of this arose when the introduction of the marine steam turbine on destroyers, rendered obsolete much of the extensively acquired experience of foreign builders and gave rise accordingly to disquisitions on the worthlessness of the new departure, which make amusing reading to-day. A fair technical education is accordingly desirable even in the case of those engaged in highly specialised and standardised branches of engineering, and the Institution of Mechanical Engineers recognised this when it inaugurated its examinations for membership, the high value of which is evidenced by the fact that on the last occasion the candidates numbered 500. Realising, however, that such examinations may prove a bar to many capable engineers not in their first youth, the council do not insist on this examination in the case of a candidate more than 33 years old, but may require the presentation of a thesis on some technical subject if uncertain as to his standard of attainments. This alternative to the examination was extended to, and proved a great boon to, many whose careers were interrupted by the war.

As one result of this policy of ensuring that members of the Institution shall be fully qualified, the Army Council now accept the associateship as a qualification for officers' pay in the Army Service Corps, the Tank Corps, and in the Royal Engineers.

In addition, the Institution has borne in mind the needs of those of the younger generation who are unable to attend other than evening classes owing to being engaged in practical work in the shops. In conjunction with the Board of Education, national certificates and diplomas are now granted to apprentices and improvers, mechanics and managers, who are unable to take complete college courses. The regulations governing the award of the certificates in question have been laid down in conjunction with the Board of Education, but appear to be open to one criticism, viz., that no provision is made for those who, being employed in villages or in the smaller towns, are unable to attend even evening classes, but have to supplement their frequently varied and valuable practical experience by private study, or with the aid of correspondence schools. As matters stand it would seem, that however high the standard thus attained, no candidate will be eligible for a national certificate or diploma unless he has not merely attained the standard demanded, but has achieved this desired end in a specified way.

It has been the established custom of the Institution to hold country meetings in addition to those at headquarters, but of late years it has been apparent that something more was needed, since, in the very nature of things, a considerable interval was bound to elapse between successive meetings in the same district. Accordingly steps were taken to form local associations of which there are now four in highly successful operation. In addition to other advantages this arrangement has made it practicable to hold the examinations for membership simultaneously at these centres and in London.

Amongst the interesting suggestions in the president's address is one for greater freedom of intercourse between the Institution of Civil Engineers and the Institution of Mechanical Engineers. In America, thanks to the munificence of the late Mr. Andrew Carnegie, all the principal engineering societies having their headquarters in New York, are housed in the same building, and arrangements have been made by which the library facilities of each body are open to members of all the others. This arrangement, of course, has many advantages, particularly in the facility it affords for the establishment of an exceptionally valuable library; but under existing conditions there are grave difficulties in the way of its adoption here.

PRODUCTION METHODS AND THE TECHNICAL MAN.

In the end, the soundness of any piece of engineering design is measured by its success in the commercial sphere, and the most brilliant mechanical device will come to nothing unless it is capable of being made and sold at a reasonable price. This condition must make methods of manufacture, and even methods of selling, if not the first interest, at least an ancillary interest of every engineer. Our technical institutions have usually taken the position that matters of this kind are outside their spheres, and certainly it would be very undesirable were they to lose sight of, or touch with, the technical interests which are their chief business. It is well, however, that at times the engineer proper should give some attention to the manufacturing and production problems which so nearly affect his interests and prosperity.

This point of view was emphasised by two presidential addresses which were delivered last Friday. At the North-East Coast Institution of Engineers and Shipbuilders, the new president, Sir Archibald C. Ross, in raising the question stated that although he might be considered to be travelling outside the usual province of the Institution, yet such matters affected the country's prosperity so vitally that one was bound to give them close attention. At the Institution of Production Engineers, Mr. Max R. Lawrence, the president, naturally did not find it necessary to strike an explanatory note when referring to production problems, but adopted somewhat the same attitude as Sir Archibald Ross when suggesting that the Institution of Production Engineers should not hesitate to deal with questions of cost and selling prices.

Sir Archibald Ross gave the name "method" to the factor in industrial life which, while apart from purely technical interests, might yet be brought within the scope of discussion in a technical institution. Under "method" he included organisation, purchasing, selling, commercial capability, manufacture, education and welfare. This is a somewhat miscellaneous list which we need not now analyse. Obviously it covers much ground, and a great deal could be said about every item. Without attempting anything of this kind there is an aspect of the question to which we may refer which is worthy of a little attention, and which we think is consonant with the spirit of the two presidential addresses to which we have alluded.

The point we have in mind is the relation which necessarily must exist between design and production methods and costs. It is in the nature of a platitude to say that design exercises an important effect on the cost of manufacture, but in spite of the better realisation of this fact which comparatively recent years have brought, it is certain that there is still much work done which could be eliminated by modifications in design which would in no way affect performance. In speaking of production methods one is inclined to think of the repetition manufactures, of which the motor car is one of the chief examples, but there are production costs in many other engineering trades than that, and the best immediate work could probably be done in engineering shops in which the blessed word "production" has never had a place. In many older established branches of engineering, designs are perpetuated for no other reason than that they are of long standing, and detail features are incorporated in new designs because they are a firm's standard practice, and with no consideration of whether manufacturing costs in the foundry or machine shop might not be materially lessened by modifications which would in no way impair the value of the finished article.

This influence of the details of design on production costs is one which may be considered to concern the drawing office more than any other part of an engineering shop, but much advantage would lie in it being brought more prominently before the attention of every engineer. The Institution of Production Engineers has done, and will no doubt continue to do, much good work in this sphere, but the matter is one not only for a specialised institution. Although we have referred to the modification of details of design as an obvious direction in which manufacturing economies can be introduced, the matter does not end there, and in many cases a complete recasting of design may be necessary to secure the full benefit of the methods which modern machines and tools have rendered possible. This type of modification removes the question out of the sphere of the pure production man and brings in the designer and theoretical worker on whose dicta modern machinery is to some considerable extent based. Men of this class will in general only be reached through the senior engineering institutions, and much good might result from well selected papers addressed to the technical audiences which attend their gatherings. The ideas inherent in the addresses of Sir Archibald Ross and Mr. Lawrence may be commended to the sympathetic consideration of the councils of other engineering institutions than those for which they spoke.

THE CUNARD LINER "FRANCONIA."

The growth of popularity of long-distance cruising in first-class liners has prompted the action of the Cunard Steamship Company in building a vessel specially designed for world touring. The Franconia, which was launched by Lady Royden, the wife of Sir Thomas Royden, Bart., M.P., the chairman of the Cunard Company, at the yard of Messrs. John Brown and Co., Clydebank, on Saturday, the 21st inst., is thus quite a new type of vessel as far as equipment is concerned. This vessel is the ninth of the 14 laid down in the Cunard company's post-war construction programme. She was originally intended for the North Atlantic service, but after the resumption of work on her hull, following the suspension due to high costs, the interior plans were considerably modified to meet the change of intention of the owners.

The vessel will possess many new features, the chief of which will be the provision of a completely-equipped sports deck. An area of 6,000 sq. ft. on one of the decks, extending to the whole width of the ship will be devoted to a large swimming pool, a gymnasium and a squash rackets court. The swimming pool will be of greater length than that of the Aquitania or Berengaria. Elaborate provision is to be made for the comfort and enjoyment of the tourist parties which the ship will carry. Garden lounges and a smoke room, representing the interior of an old English inn with an ingle neuk, will be features of the saloon accommodation.

The principal dimensions of the Franconia are: 624 ft. in length, 74 ft. in breadth and 45 ft. in depth. She has a gross tonnage of 20,000 and will travel at an average sea speed of 16 knots. Accommodation is provided for 330 first-class, 420 second-class, and 1,000 third-class passengers, and a crew of 410. There are to be eight decks. A double bottom extending fore and aft for the complete length of the ship will be used, along with deep tanks for the storage of oil fuel and, in addition to the stores for ship's use, the vessel has a capacity of about 285,000 cub. ft. of general cargo space.

The propelling machinery is to be of the geared turbine type, making use of superheated steam, The steam generating plant will consist of three double-ended and three single-ended marine boilers, designed for a working pressure of 220 lb. per square inch. The mean diameter of the boilers will be 17 ft. 6 in. and the lengths of the double and single-ended types are to be 22 ft. 6 in. and 11 ft. 6 in.

respectively. The single type will have four furnaces with separate combustion chambers, while the double-ended ones will have a similar construction for each end, that is eight furnaces in each unit. The total heating surface of all the boilers will amount to 29,160 sq. ft. and the combined grate area will be about 746 sq. ft. Smoke-tube superheaters capable of giving a superheat of 200 deg. F., will be installed. Oil burning on the Wallsend-Howden pressure system is to be adopted. The installation will be arranged on the duplex system with four complete sets of pumping and heating plants, two of them of large size and two small ones. Half of this equipment will act as a standby. The boiler furnaces are to be arranged for quick conversion from oil to coal burning or the reverse. Howden single inlet fans are to be used for the forced draught system. There are to be two pairs of fans, driven in pairs by electric motors.

The complete turbine installation is to be capable of developing 12,500 s.h.p. The twin-screw propeller will be driven through double reduction helical gearing. Each of the two sets of turbines, will consist of three components—high, intermediate and low pressure turbines. The high and the intermediate pressure turbines in each unit will be connected in tandem and drive through a flexible coupling to one of the pinions. The low pressure turbine will drive the other pinion of the first reduction gearing through another flexible coupling. The drives obtained from these pinions will be taken through the second reduction pinions to the main shafts. The astern turbines are to be incorporated within the casings of the intermediate and the low-pressure ahead turbines. The power available for astern working will be about 70 per cent. of the ahead value. Adjusting blocks of the Michell type will be fitted to the turbines, and the bearings of both turbines and gearing are to be arranged to work under forced lubrication. The condensers are of the underhung type, and one is to be bolted direct to the exhaust branch of the low-pressure turbines. The propeller thrust will be taken up by blocks of the Michell type fitted beside the gearing. The two propellers are of the built-up type with four manganese bronze blades on each, fitted to cast steel bosses. The propellers will run at about 90 r.p.m.

The equipment of auxiliary machinery to be fitted will comprise two circulating pumps of the turbo-driven centrifugal type, one turbo-driven and two direct-acting feed pumps, extractor pumps, air ejectors and other fittings in connection with the Weir closed-feed system, as well as the necessary outfit of pumps for forced lubrication, sanitary, fresh water and other services, together with water evaporating and distilling plant. The electrical equipment will show a considerable extension over that of earlier Cunard vessels in the use of electrical power for the operation of deck machinery, the capstans, windlass, winches and steering gear. This power is to be used throughout the ship for passenger elevators, hoists for baggage, stores and coal, for driving the refrigerating plant and the galley and pantry machinery. Electric cooking and heating appliances will find extensive use in the Franconia, and electric sunbaths will be available. The ventilation is to be maintained by natural means supplemented, where necessary, in the passenger accommodation by a mechanical installation. The thermotank system of supplying fresh air, heated to any desired degree and under the control of the passengers, will be installed. Radiators are to be fitted in the cabins, corridors and public rooms.

Thirty-two lifeboats will be carried, and these will be arranged for quick handling by means of Welins' quadrant davits. Fire screen bulkheads are to be fitted to localise any outbreak of fire which can then be extinguished by the use of the fire hydrant equipment and chemical extinguishers.

University of London, University College.—A public lecture will be delivered in the Physics Lecture Theatre, by Professor E. G. Coker, F.R.S., on Thursday, November 2, at 5.30 p.m., on "Recent Photo-Elasticity Researches in Engineering Problems," illustrated with experiments by aid of polarised light. The lecture is open to the public without fee or ticket.

NOTES.

Lloyd's Register of Shipping.

In view of the unprecedented decline in the shipbuilding industry, to which frequent reference has been made in our columns, it is not surprising to find from the annual report of Lloyd's Register which has just been issued that the tonnage receiving the Society's classification during the year ended June 30 last has fallen considerably below the figures for the previous years. During the first three post-war years an average of about 3¾ million tons of merchant shipping was classed annually, the record figure for any one year being reached in 1919-20, when over 4¼ million tons was classed. The new tonnage to which classes have been assigned during 1921–22 included 623 vessels making 2,523,992 tons in the aggregate, which, although a reduction of about 22 per cent. on the figure for the previous year, is still well above that for the last complete pre-war year, viz., 1913-14; for that period the tonnage classed amounted to 2,020,185 tons. Of the vessels classed during the year under review, 32 are of over 10,000 gross tons, as compared with only 10 exceeding that tonnage classed in 1920–21. The two largest vessels classed last year were the Giulio Cesare (21,848 gross tons) for the Navigazione Generale Italiana, and the Empress of Canada (21,517 gross tons) for the Canadian Pacific Railway Company. Both these vessels have been illustrated and described in our columns, the former on page 323 of Vol. 111 and page 662 of Vol. 112, and the latter on pages 255, 317 and 385 *ante*. Vessels of all types of construction intended for carrying oil in bulk, and built to class during the year, numbered 114, and had a gross tonnage of 602,399. This figure, although somewhat lower than that for the previous year, forms a higher proportion of the total tonnage classed, being 24 per cent., as compared with 18 per cent. It may be of interest to mention that the total tonnage of oil-carrying vessels in the Register Book is now over 5,000,000 tons. The development in the use of oil fuel is also illustrated in the report, which shows that 55 per cent. of the new tonnage classed was arranged for that fuel. A number of existing passenger vessels, including the Aquitania, Berengaria and Mauretania, have also been converted for oil burning during the year, under the Society's supervision. The use of internal-combustion engines for marine propulsion has developed steadily, the tonnage of motor vessels on the Register Book having increased by 293,360 tons (over 23 per cent.), from 1,248,800 tons in July, 1921, to 1,542,160 tons in July last; in July, 1914, the tonnage of motor vessels was only 234,287 tons. An outstanding feature of the year's work of the Society has been the adoption by the Committee of new rules for the construction and classification of steel vessels, but as these have already been dealt with on page 113 *ante*, it is not necessary to refer further to them here. We may mention, however, that the rules for the construction of oil-carrying vessels are now in course of revision.

Competitive Trials of Gliders.

It will be remembered that one of the effects of the Treaty of Versailles, which prohibited the Germans from building power-driven aeroplanes, was to give rise to a considerable development in the construction and use of motorless aeroplanes, or "gliders," in that country. Outside aeronautical circles, the developments attracted but little attention until August last, when it was reported that a German pilot, Hentzen, had remained aloft in a "Vampyr" glider for 3 hours 10 mins. in the Rhön mountains. This so greatly exceeded the duration of previous flights of this character that public interest was aroused, and, to encourage similar developments in this country, a prize of 1,000*l.* was offered by the *Daily Mail* to the pilot making the longest flight of over 30 mins. duration and afterwards landing within 800 yards of the starting point. The arrangements for the trials were made by the Royal Aero Club, the site selected being Itford Hill, on the South Downs between Lewes and Newhaven, and the trials were carried out there during the week ended Saturday, the 21st inst. About 36 gliders of various types were entered and some notable flights were made, the longest being that by a French pilot, M. Maneyrolle, on the last day of the trials. M. Maneyrolle remained up at a height of about 200 ft. for 3 hr. 22 min. in a wind of about 30 miles per hour and made a voluntary descent after nightfall, thus establishing a new record as well as winning the competition. The glider used was of the tandem-monoplane type with a fuselage of triangular cross-section, and the flight above referred to, we understand, was the first occasion it had been in the air. The next best flight was accomplished on Tuesday, the 17th inst., by Mr. F. P. Raynham, who remained in the air for 1 hr. 53 min. in a Handasyde glider, but mention should also be made of a flight of about 90 min. duration by Squadron-Leader A. Gray in a glider built up of disposal parts. This pilot ascended on Saturday, the 21st inst., some two hours after M. Maneyrolle, and the two machines alighted together on account of the darkness. Another noteworthy feat was that of Capt. G. P. Olley, who, on the same day, flew for 49 min. with a passenger in a two-seater glider of Fokker design. This flight, we understand, constitutes a record for a glider carrying a passenger in addition to the pilot. The results are certainly very interesting, and it is hoped that a full technical report of the trials will be issued. Although it is, of course, possible that experiments with gliders may lead to improvements in the design and methods of handling of power-driven aeroplanes, the special conditions as to wind direction and velocity, land contour, &c., which have to be complied with in order that the former may be successfully employed, would seem to preclude their use for commercial or military aviation. Moreover, it would appear from the Itford Hill trials that, if anything, more skill is required for piloting a glider than a power-driven machine, and if this be the case, gliding is hardly likely to become popular as a form of amusement.

Railway Accidents.

The report on railway accidents for the year 1921, drawn up by Colonel J. W. Pringle, was issued a few days ago. In considering this report it should be remembered that during the year in question both passenger and freight traffic showed a considerable reduction on the previous year and also on the figures for some years before the war. This was primarily due to the direct effects of the coal strike. Compared with the previous year the total number of persons killed on the railways of this country showed a reduction of over 200, viz., from 991 to 784. The numbers injured also showed a considerable decrease. The total figures in these returns are not actually of very great interest, since they include casualties which happen to occur on railway premises although having no connection with trains. The common impression conveyed by the returns is that the business of travelling and the transport industry are dangerous to life and limb, whereas many of the accidents included have no relation to the transport business of the companies, and might equally well occur to people on other premises. Such accidents account for 4 fatal and 569 non-fatal casualties to passengers, and altogether 13,831 casualties to employees and others. When it is mentioned that the total casualties of all classes numbered 20,285, the falsity of the impression resulting from reckoning these as railway accidents, will be perceived. Coming to the casualties more strictly connected with transport, the number of passengers killed in train accidents was three times that of the previous year (18 against 6), but the injured were fewer by nearly 100. Collisions accounted for nearly the whole, derailments only accounting for 10 cases of injury, and failures of rolling-stock for 4 injuries. The number of casualties to employees also showed a decrease, although again the fatal cases were more numerous than in the previous year. Among the employees, engine drivers sustained the largest number of fatal injuries in accidents occurring while working trains, though goods guards and brakesmen showed the largest number, including fatal and non-fatal cases. Firemen showed the largest number of killed in proportion to the number employed. The most serious accident was that at Abermule. Five accidents involved loss of life. Of the cases inquired into 3 were due to failure of equipment, 6 to the failure of enginemen to

observe signals or give effect to regulations, 6 to other employees failing to give effect to regulations, 2 to faulty methods of signalling and the one, referred to by name above, to irregular single-line working. As regards coupling accidents the year shows a considerable decrease (3 killed and 367 injured, compared with 15 killed and 543 injured in 1920). Coupling operations with the pole have resulted in 2 employees being killed and 194 injured, while coupling without a pole resulted only in 24 being injured. This, of course, is no indication of the relative danger of using the pole, but is an indication that comparatively few men now risk coupling the three-link coupling without the aid of that appliance. It is considered by the Inspector that the safety propaganda instituted by the several companies is having a good effect.

The New American Tariff.

The Board of Trade has issued detailed particulars of the United States "Tariff Act of 1922," which is popularly known as the "Fordney-McCumber Act," from the names of the chairmen of the committees of the House of Representatives and Senate, to whom the measure was referred for consideration and report. It provides for the imposition of duties on a considerably higher level than those previously in force. The report on the Bill, dated July, 1921, stated that the framers of the Act of 1913 had contended that lower rates would reduce production costs and enable Americans to capture foreign trade, the result being industrial activity and general prosperity. From the date of the enactment of the low rates, however, until the outbreak of the war in Europe, exports from the States not only did not increase, but declined with rapidity and alarming regularity, whilst imports increased. America, it was added, did not capture foreign markets, but foreigners captured American markets; industry languished and unemployment prevailed. The war checked the flood of foreign goods; it created on the other hand, as was fully admitted, a demand for American supplies of every description, and the adverse conditions of the autumn and winter of 1913 and of the early summer of 1914 were to a large extent forgotten during the continuation of hostilities. With the resumption of production in Europe, foreign competition, the report further stated, was once more being keenly felt, industry and trade in the United States were at a low ebb, and this depression "was the inevitable result of the offering of foreign goods upon the American market at less than the American cost of production." At that same time, July, 1921, a proposal was put forward to adopt the "American Valuation" system of assessing *ad valorem* duties on imports; this was much criticised both within and outside the United States. The Bill passed the House of Representatives on July 21, 1921, but it was not until April, 1922, that the Senate Committee on Finance reported upon it. The Committee considered that the disadvantages of the "American Valuation" plan would not be adequately offset by any advantage that might be secured by it, and recommended that the value basis of existing law should be continued; "American Valuation," as originally contemplated, was rejected, and the Committee re-wrote the *ad valorem* rates on the basis of foreign values and made numerous alterations in the specific rates. The Bill was passed by the Senate on August 19; it was then referred twice to a conference of both Houses, and was finally enacted a few weeks ago. The two main features of the measure, according to the analysis made by the Board of Trade, are a marked advance in the rates of the Tariff Act of 1913, and the provision for a flexible tariff, including "American Valuation as an emergency measure" where mere alteration of rates fails to meet the special conditions with which American industry may be faced. As regards the rates of duty, opponents of the new Act declare that they are higher than ever before, and are practically prohibitive for many classes of manufactured goods. Certain sections of American opinion consider the flexible tariff provisions as unconstitutional, and predict that this view will be shared by the Supreme Court. The following are a few figures: Textile machinery, 1913 tariff, 20 per cent. *ad valorem*, 1922 tariff, 35 or 40 per cent. *ad valorem*; aluminium, aluminium scrap, aluminium alloys, crude, 2 cents per pound, now 5 cents per pound; spiegeleisen containing not more than 1 per cent. of carbon, formerly free, now $1\frac{7}{8}$ cents. per pound on manganese content, plus 15 per cent. *ad valorem*; if containing more than 1 per cent. of carbon, formerly free, now 75 cents per ton.

LITERATURE.

The Design of Masonry Structures and Foundations. By Clement C. Williams, C.E., Professor of Civil Engineering, University of Kansas. London and New York: McGraw-Hill Book Company. [Price 25s. net.]

Professor Williams is justified in saying that the development of the masonry arch is one of the most notable achievements in engineering, as it certainly is one of the most permanent. Arches have indeed existed from time immemorial as empirical structures, whose stability could be determined only by results. It was not till late in time that mathematical analysis indicated any rules that could be followed with precision, though it must be admitted that some very considerable structures were produced with very little assistance from theory. The need of an adequate theory probably was not felt, for the delay in its production was not occasioned by any want of analytical power. The armoury of the mathematician possessed all the necessary tools, no fresh mathematical creation was necessary to supply the logical instrument requisite to solve the problem that confronted engineers in construction work. But it was not till 1879, that Weyrauch demonstrated an elastic theory of arch action, which provided for the construction of steel and masonry arches a sound theory, that gave confidence to design, permitted increased economy in working, and secured a wide recognition in practice.

This theory has become the standard for calculating stresses in arches, and the same writer has also elaborated Coulomb's theory for determining internal stresses in a homogeneous granular mass, which likewise enjoys a considerable vogue. Professor Williams has followed both these theories with some modifications, although in the former case, at least, more recent alternatives have been proposed in the method known as the ellipse of elasticity, due to Professor Melan, and one founded on the principle of least work by Professor Spofford. The "line of thrust theories," approved by Rankine and some other authorities, are discredited, as being based on hypotheses which were more or less conjectural. We imagine, however, that if these "indefinite and unsatisfactory theories" have disappeared from modern text books, past practice and tradition serve as guides to the limit of safe procedure. The history of failure will therefore still serve as a useful warning and should not be neglected. The author's instances of collapse in some modern structures should fulfil a salutary purpose, for experiment cannot be wholly superseded by theoretical deductions. Further, in many cases, stresses under specified conditions may become too complex to admit of analysis, in others, the factors introduced into the equations cannot be determined with the numerical exactness which allows calculation to be carried out with refinement. In the design of masonry arches, the loads and stresses depend directly upon the form of the arch-ring, and this form itself depends upon the loads to be supported. Consequently, the general design is suggested by empirical formulæ or by previous experience, and when submitted to analytical investigation the necessary modifications will suggest themselves. An element of uncertainty will still exist due to the variability in the quality of the structural materials, and the method in which they are used. The introduction of reinforced concrete, by which the tensile strength of masonry is made comparable with the compressive strength has done much to widen the gap between the older and modern practice, making necessary a re-examination of conventional rules. The author, while disclaiming any intention of competing with technical treatises, wholly devoted to the consideration of concrete, devotes no inconsiderable portion of his earlier chapters to the manner of use of concrete in masonry construction. The formulas governing the design of structures following the usual lines are trustworthy within limits, but the factor of safety cannot be dispensed with and is much in evidence in these pages.

The masonry structures here considered do not as a rule constitute a project in themselves, but form generally a necessary and subsidiary part of a larger design intended for some economic use. The author is exclusively concerned with the conditions which determine the design of the particular structure under consideration and not with the functional requirements for which the structure may be subsequently used. The object of a lofty chimney, for example, may be to produce a certain draught, to give a desired velocity to escaping gases, and other objects, but the manner of securing these objects is outside his purpose. The distinctive structural problem arising here depends upon the height in connection with the small area of the base, and to this point the discussion, as an engineering problem, is directed. Similarly, the origin and behaviour of stresses in the design of grain-bins come within the scope of the inquiry, but the provision of the facilities required in handling grain, or other material, forms no part of the scheme. This limitation is important; the treatment is directed to the study of principles underlying the design of structures of a group, rather than to the design of any one particular class.

Subject to this restriction the necessity for which will be readily admitted, the treatment is adequate and proportionate, covering a large field. Besides masonry arches to which considerable space is allotted, the forces acting on dams and retaining walls under various conditions are investigated, and suitable designs suggested. In railway construction, bridges, abutments and piers, viaducts and trestles, with many related structures, come under review. The last three chapters relate to foundations, both on dry ground and under water, the latter providing much useful information on the use of coffer dams and caissons. A vast amount of material has therefore to be arranged and discussed, but the author handles the details with ease and directness, by pursuing a clear and systematic plan. His aim is logical and precise, and he has the art of making the collected information bear on the conclusion to which he would direct attention. The general plan followed whether treating of a masonry arch, the foundation of a dam or the construction of a bridge abutment is to make evident the function the structure has to serve and how each of the objects sought is secured. If it be a railroad bridge abutment, for example, the work of the engineer must be arranged to fulfil certain requirements. These will embrace the necessary support at the end of the bridge span, the retention of the earth embankment carrying the roadway, the support of the track as it passes from the earth road bed to the approach embankment on to the bridge floor, and the provision of resistance to the traction forces which will arise. Next the particular parts of the scheme that can be controlled by the engineer with the view of accomplishing each of these objects are considered and how each may be most appropriately employed, or varied, to secure the desired results. The area given to the footing must be of such extent that the pressure on the soil may not exceed its bearing capacity; the body of the abutment must be designed to possess the necessary strength to support the bridge and to withstand the various forces transmitted to it from the bridge span, and from the fill back of the abutment. The bridge seat must be able to fulfil its function, the back wall must prevent the earth falling forward on to the bridge seat, while the wing walls must be able to retain the side slopes of the embankment and possibly to prevent scour from a running stream. Finally, the practical devices for effective use are discussed; in this instance, pile abutments, steel cylinder abutments, mass, and reinforced concrete abutments, the peculiar advantages of each are weighed and debated under specified conditions with the view of determining that which best satisfy the threefold conditions of economy, stability and appearance.

This general illustration drawn from a chapter taken at random must serve to indicate the extent and variety of the programme which with the

necessary variations is repeated through many chapters, each dealing with some typical structure. It should suggest that notwithstanding the treatment covers a wide area, it is full and thorough, and could hardly have been attempted but for the assumption that the student has a knowledge of mechanism and some familiarity with the stress diagram. Writing for Americans the examples and illustrations are naturally taken from American sources, but these are of a very varied character and well selected. There is, we believe, but one reference to modern English work, and that is introduced to disparage the ornate towers of the Tower Bridge, which are held to compare unfavourably with the stately towers of the Brooklyn Bridge, which follow the simple lines developed by the designing engineer. Generally it must be admitted that the few remarks on æsthetics are well founded, are directed against meretricious ornament, and aim at securing by means of suitable composition the accentuation of strength, massiveness, and dignity, inherent in a great mass of masonry.

BOOKS RECEIVED.

Dissoziation der Gase. Von Dipt-Ing. A. Schelest. Berlin: Kniga Buch- und Lehrmittelgesellschaft, M.B.H.

Standard Seamanship for the Merchant Service. By Captain Felix Riesenberg, C.E. London: The Library Press, Limited. [Price 36*s.* net.]

The Electrical Contractors' Year Book, 1922–23. London: The Electrical Contractors Association, Incorporated. [Price 2*s.* 6*d.*]

Department of Scientific and Industrial Research, British Association for the Advancement of Science. Fourth Report on Colloid Chemistry and its General and Industrial Applications. London, Manchester, Cardiff and Edinburgh: His Majesty's Stationery Office. [Price 5*s.* 6*d.* net.]

A Text Book of Machine Construction and Drawing. By Henry E. Merrett, B.Sc., and Maurice Platt, M.Eng. London: G. Bell and Sons, Limited. [Price 7*s.* 6*d.* net.]

Marine Insurance for the Shipper. By Joshua Lea. Manchester: The *Manchester Guardian*, Limited. [Price 1*s.*]

The Roadmender Country. By Lorma Leigh. London: The Homeland Association, Limited. [Price 7*s.* 6*d.* net.]

Transactions of the American Institute of Mining and Metallurgical Engineers, Vol. LXVII. 1922. New York: Offices of the Institute. [Price 4 dols.]

Proceedings of the Institution of Mechanical Engineers, January to May, 1922. London: Offices of the Institution.

The Universal Directory of Railway Officials, 1922. Compiled chiefly from official sources under the direction of the editor of *The Railway Engineer*. London: The Directory Publishing Company, Limited. [Price 20*s.* net.]

Smithsonian Institution. United States National Museum. Bulletin No. 122. *A Monograph of the American Shipworms.* By Paul Bartsch. Washington: Government Printing Office. [Price 30 cents.]

The Marine Power Plant. By Lawrence B. Chapman. First edition. New York and London: McGraw-Hill Book Company, Inc. [Price 20*s.* net.]

Standard Pocket Book for Electrical Engineers. Frank F. Fowle, S.B., Editor-in-Chief. Fifth edition, thoroughly revised. New York and London: McGraw-Hill Book Company, Inc. [Price 30*s.* net.]

The Chemistry and Technology of Gelatin and Glue. By Robert H. Boyne. First edition. New York and London: McGraw-Hill Book Company, Inc. [Price 30*s.* net.]

Factory Storeskeeping. The Control and Storage of Materials. By Henry H. Farquhar. First edition. New York and London: McGraw-Hill Book Company, Inc. [Price 12*s.* 6*d.* net.]

Mastering Power Production. The Industrial, Economic and Social Problems Involved and their Solution. By Walter N. Polakov. London: Cecil Palmer. [Price 30*s.* net.]

Scottish Canals and Waterways. Comprising State Canals, Railway-Owned Canals and Present-Day Ship Canal Schemes. By Edwin A. Pratt. London: Selwin and Blount, Limited. [Price 10*s.* 6*d.* net.]

Transactions of the Newcomen Society. For the Study of the History of Engineering and Technology. Vol. I. 1920-21. London: Published by the Society. [Price 20*s.*]

Aeronautical Research Committee, Reports and Memoranda. No. 541. *Stability and Resistance. Experiments on a Model of Vickers Rigid Airship R. 80.* By J. R. Pannell, A.M.I.M.E., R. Jones, M.A., and G. N. Pell, B.Sc. [Price 7*d.* post free.] No. 791. *On the Determination of the Stresses in Braced Frameworks.* Part III. *The Effect of Axial Loading, Torsion, Flexure and Shear upon a Braced Tube of any Uniform Section.* By R. V. Southwell. London, Manchester, Cardiff and Edinburgh. His Majesty's Stationery Office. [Price 7*d.* post free.]

United States Geological Survey. Bulletin No. 735—D. *Silver Enrichment in the San Juan Mountains, Colorado.* By Edson S. Bastin. No. 736—C. *Geology of the Wilas Area, Ranger District, Texas.* By Carroll E. Dobbin. Washington: Government Printing Office.

INDUSTRIAL NOTES.

According to a report issued by the Ministry of Labour employment continued bad during September, and showed little general change as compared with the previous month. Some improvement was reported in the pig-iron industry, and in iron and steel manufacture, but there was a further decline in employment in the cotton industry. The percentage unemployed among members of trade unions from which returns are received was 14·6 at the end of September, as compared with 14·4 at the end of August, and 14·8 at the end of September, 1921. The percentage unemployed among workpeople insured under the Unemployment Insurance Act, in Great Britain and Northern Ireland, was 11·9 on September 25, as compared with 12 on August 21. The total number of workpeople registered at the Employment Exchanges as unemployed on September 25 was approximately 1,368,000, of whom 1,117,000 were men and 168,000 were women, the remainder being boys and girls. At the end of August the number on the live register was 1,378,000, of whom 1,121,000 were men and 173,000 were women. The number of vacancies notified by employers to exchanges and unfilled on September 25 was 12,500, of which 2,800 were for men and 8,000 for women, compared with 12,700 on August 28.

In the industries for which statistics are compiled by the Labour department, changes in wages rates reported as having taken effect in September resulted in an aggregate reduction of about 297,000*l.* in the weekly full-time wages of nearly 1,300,000 workpeople, and an increase of about 30,000*l.* in the weekly wages of 395,000 workpeople. Among those workpeople who sustained reductions in wages, the principal group were men employed in the engineering industry, whose weekly rates, in the principal centres of the industry, were reduced by a third instalment of 5*s.* 6*d.* a week, making a total reduction of 16*s.* 6*d.* a week during the past three months. Other groups of workpeople affected by reductions included steelworkers at Sheffield, men in ship-repairing yards in most of the principal districts, railway carriage and wagon builders and repairers, letterpress printers in provincial towns in England and Wales, vehicle builders, &c. As a result of orders made under the Trade Boards Acts there were reductions in the minimum rates of wages fixed in the stamped or pressed metal wares, flax and hemp, and sack and bag trades in Great Britain. The workpeople whose wages were increased in September were mostly coal miners in the Yorkshire and the East Midland area, and in South Wales and Monmouthshire. In Yorkshire and the East Midlands there was a general increase of rather over 3 per cent. on current rates, following on the ascertainment of the proceeds of the industry for July.. In South Wales and Monmouthshire the wages of the lower-paid day wage workers were raised by varying amounts under the terms of an award granting "subsistence" allowances to these workpeople. Since the beginning of 1922 the changes in rates of wages reported to the department have resulted in a net reduction of over 3,900,000*l.* in the wages of nearly 7,500,000 workpeople, and a net increase of about 11,500*l.* in the wages of 75,000 workpeople.

The number of trade disputes involving stoppages of work, reported to the department as beginning in September, was 31. In addition, 30 disputes which began before September were still in progress at the beginning of the month. The total number of workpeople involved in all disputes in September (including those workpeople thrown out of work at the establishments where the disputes occurred, though not themselves parties to the disputes) was nearly 15,000, as compared with 31,000 in the previous month and 20,000 in September, 1921. The estimated aggregate duration of all disputes during September was about 140,000 working days, as compared with 310,000 days in August, 1922, and 145,000 days in September, 1921. The principal dispute in progress in the month was that which began on September 21, involving colliery and coke-oven workers at Ebbw Vale, and rendering idle a considerable number of workpeople at blast-furnaces and steel works.

Since the beginning of 1922 the stoppages of work, owing to trade disputes, reported to the department, had involved over 500,000 workpeople. The aggregate duration of the stoppages had been nearly 20,000,000 working days.

On September 30 the average level of retail prices of all the commodities taken into account in the statistics prepared by the Ministry of Labour was about 78 per cent. above that of July, 1914, as compared with 79 per cent. on September 1. The highest point reached by the figure was 176 per cent. above the pre-war level, in November, 1920, and the figure now recorded is lower than that for any date since October, 1917.

As announced on page 437 *ante*, the South Wales Miners' Federation had decided by a large majority in favour of tendering, on the 23rd inst., last Monday, 14 days' notice to cease work, with a view to force into the Federation those miners who do not belong to it. It had been decided since that the safety and maintenance men would remain at work during the miners' strike. News was received at the commencement of the week to the effect that an exceedingly small proportion of the union miners have tendered their notices, and according to every probability there will be no strike. This means that the union miners completely disapprove the action of their executive, or leaders; in view of such a vote of no-confidence the only straightforward action open to the latter would be to resign. It is to be hoped that this decision on the part of the miners will have the effect of hastening the settlement of the Ebbw Vale dispute. At the time of going to press it is reported that work at Ebbw Vale may be restarted next Monday.

In the course of his presidential address to the Belfast Association of Engineers, delivered yesterday, Mr. Atholl Blair stated that there were to-day lying idle in the United Kingdom over 500 vessels of our ocean-going fleet, having a tonnage close upon 1,000,000 tons. This represented exactly six months hard work of all combined in the production of ships for the United Kingdom in 1920. Our shipping to-day was as great as it was before the war; to that extent we had recovered from the German submarine campaign. But to-day the total world's carrying trade had greatly diminished from what it was previous to the war. The emergence of an American mercantile fleet, subsidised as it was, had increased the tonnage for the carrying trade. The United Kingdom shipbuilding tonnage for 1921 fell to 1,538,052, or three-fourths of 1920, when there were launched 618 vessels having a tonnage of 2,055,624. This figure for 1920 was only slightly more than the tonnage of 1913, namely, 1,932,153 tons, and compared just a little favourably with 1,828,343 tons for 1906. With all the increased capacity for shipbuilding, the tonnage launched in 1921 little more than equalled what the United Kingdom actually accomplished twenty years ago, namely, 1,524,739 tons for 1901.

It is reported that remarks have been put forward to the effect that building trade craftsmen and labourers employed in engineering works and steel works in the Midlands are paid a higher wage than the engineering and steel manufacturing craftsmen and labourers. Building trade craftsmen and labourers receive 78*s.* 4*d.* and 58*s.* 9*d.* respectively, whilst the wages of the engineering craftsmen and labourers are 59*s.* and 40*s.* 6*d.* per week. It is claimed that the wages of the building trade operatives should be brought down accordingly. The point is under discussion, and it is difficult for any outsider to hazard an opinion in the matter. It is fortunate for the Midland works that they do not require the services of London scavengers; some of these, we are informed, are paid as much as 4*l.* per week.

An editorial article in *The American Machinist* asks one to suppose all union labour adopting a new way of paying the "leaders," giving them an increase in salary when their men had obtained higher wages, a reduction when the wages of the men had been reduced, and no salary at all when there was a strike. If this were done, the journal intimates that there would not be one strike in ten centuries, and all the union leaders' weeklies, monthlies and quarterlies would promote scientific union management. "This will never happen," adds the journal, "it is not practical. The union leaders cannot be expected to introduce such a revolutionary method, and if they do not introduce it, who will? The men? What have they to say about such matters?" It is quite possible, in our opinion, that the men's "leaders" could afford to remain without salary during the period of a strike, and this weakens our contemporary's argument.

Fire Damp Indicator.—In conjunction with the German Coal Office the Prussian Ministry for Trade and Industry invites international competitions, open to everybody, for a firedamp indicator. The indicator must be suitable for general use, and must indicate the presence of 2 per cent. and more of methane in explosive or non-explosive mixtures. The instrument should itself be explosion proof in the sense that it must be as safe as an enclosed electric lamp. The instrument may or may not be combined with the ordinary safety lamp. Complete instruments or models should be submitted, but drawings will also be considered. Competitions should be sent in by October, 1923. The prize, which may be divided, has been fixed at 500,000 marks, which is a very indefinite sum; further particulars can be obtained from the Ministry.

DOUBLE-REDUCTION GEARS FOR TURBINES.

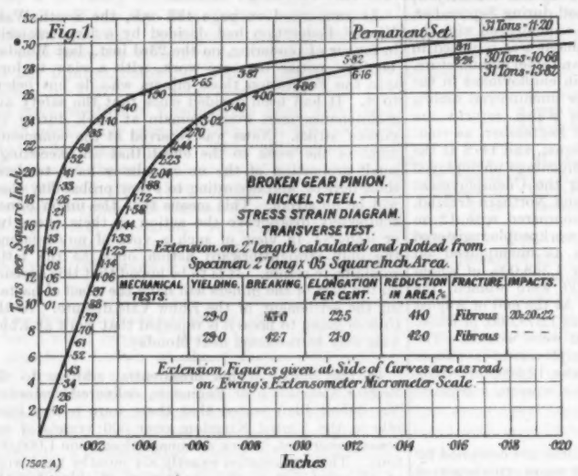


Fig. 1.
Permanent Set.
31 Tons - 11·20
30 Tons - 10·68
31 Tons - 13·82
Tons per Square Inch.
Inches
BROKEN GEAR PINION.
NICKEL STEEL
STRESS STRAIN DIAGRAM.
TRANSVERSE TEST.
Extension on 2" length calculated and plotted from Specimen 2" long x ·05 Square Inch Area.
Extension Figures given at Side of Curves are as read on Ewing's Extensometer Micrometer Scale
(7502 A)

MECHANICAL TESTS.	YIELDING.	BREAKING.	ELONGATION PER CENT.	REDUCTION IN AREA %	FRACTURE	IMPACTS.
	23·0	45·0	22·5	41·0	Fibrous	20·20·22
	29·0	42·7	21·0	42·0	Fibrous	- - -

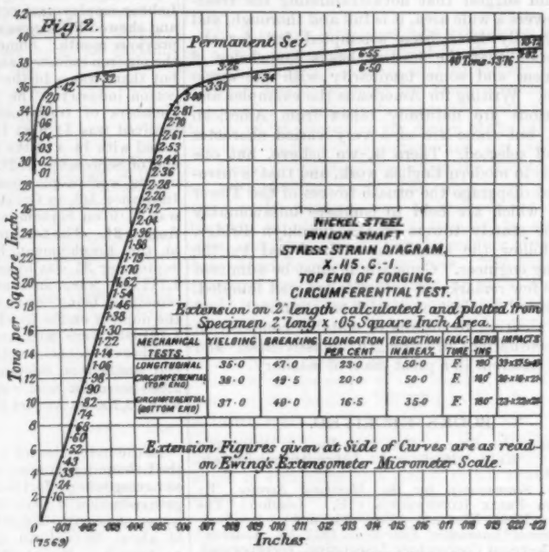


Fig 2.
Permanent Set.
Tons per Square Inch.
Inches
NICKEL STEEL
PINION SHAFT
STRESS STRAIN DIAGRAM.
X.N.S.C.-1.
TOP END OF FORGING.
CIRCUMFERENTIAL TEST.
Extension on 2" length calculated and plotted from Specimen 2" long x ·05 Square Inch Area.
Extension Figures given at Side of Curves are as read on Ewing's Extensometer Micrometer Scale.
(7569)

MECHANICAL TESTS.	YIELDING	BREAKING	ELONGATION PER CENT	REDUCTION IN AREA %	FRACTURE	BEND	IMPACTS
LONGITUDINAL	35·0	47·0	23·0	50·0	F.	180°	23×23·5×23
CIRCUMFERENTIAL (TOP END)	38·0	49·5	20·0	50·0	F.	180°	20×19×22
CIRCUMFERENTIAL (BOTTOM END)	37·0	49·0	16·5	35·0	F.	180°	23×22×23

CARBONEX CASE-HARDENING COMPOUNDS.

The basis of all case-hardening compounds is carbon, and their action is to form carbon monoxide which readily gives up its carbon to the iron or steel under treatment. The released oxygen then takes up another atom of carbon and so the process goes on. For the best results the purity of the carbon is essential, for if it exists in a material high in ash the work may not be regular, while the presence of sulphur or phosphorus is obviously objectionable. Provided that requirements as to purity are met, which is by no means always the case, rapidity of action and effectiveness of access to every part of the surface to be hardened are also highly desirable. Rapidity is important from every point of view. Not only are the costs of plant, heat and labour reduced for a given output of work, but the structure of the steel is less affected owing to the shorter exposure to heat and distortion of the work is therefore minimised. This has been so well recognised that several manufacturers of case-hardening compounds have sought to obtain rapidity of action by using a certain proportion of barium carbonate, a substance which has long been known to promote the evolution of carbon monoxide.

The usual form of case-hardening compound is a more or less coarsely granulated material, in which the articles to be hardened are packed, the whole being contained in iron boxes while in the furnace. Messrs. Carbonex, Limited, of St. Stephen's House, Victoria Embankment, London, S.W. 1, have, however, introduced a compound in the form of a paste which does away with the necessity for a box, and indeed with that of a special furnace, for by its use it is perfectly possible to case-harden ordinary objects in a blacksmith's fire. The Carbonex paste is a black plastic substance which can be stuck on the surface of the article to be treated or kneaded round it with the fingers. It is put on to a thickness of about half an inch, and the work can then be placed straight in the furnace. If it is then watched, as soon as the working temperature is reached the surface of the material is seen to be slowly heaving, which is said to be due to the partial retention of the carbon monoxide, by a flux which is formed at the surface. After sufficient time has elapsed the work is removed and cooled, the Carbonex then appearing as a black porous crust, hard and brittle and very readily removable.

The action is very rapid, and the steel can be carburised to a depth of $\frac{1}{16}$ in. in 2 hours, after the working temperature of 950 deg. C. has been reached. Thus ordinary small articles can be carburised to the standard depth within about 2½ hours of the time at which they are placed in the furnace. The same depth of carburisation would require from 4 hours to 8 hours with the usual case-hardening powders, according to their composition. A further advantage is the ease and certainty with which relatively inaccessible surfaces can be treated. We recently had the opportunity of witnessing the practical application of Carbonex compound at the works of the Expert Tool and Case-Hardening Company, Limited, of 4, Chip-street, Clapham, a small firm which has specialised in the hardening and heat treatment of difficult work of all kinds. As illustrating one of the features of the compound, we may mention the case of a small drilling jig made from ¾-in. steel plate, through which were a number of holes $\frac{7}{16}$ in. diameter, the interiors of which had to be hardened. The paste was pressed into the holes before the plate was put in the furnace, and was found there when it was removed. We were assured that holes of as small a diameter as 1 mm. were effectively hardened internally by the same method.

Another instance in which both the plastic nature of the paste and its rapidity of action were advantageously shown was in connection with the hardening of a camshaft for a sleeve-valve petrol engine. This shaft contained a gear wheel at the centre, and on each side of it were two short-throw cranks. The object was to carburise the crank pins deeply, so as to allow for machining, and to carburise the wheel teeth much less deeply, so as to retain an uncarburised core in each tooth. The usual method of doing such a job would be to carry it out in two separate operations, the teeth being given a shorter exposure to the carburising material than the crank pins. In this case, however, Carbonex paste was pressed around the crank pins only, and the shaft was then embedded in ordinary hardening compound. The difference in the rates of penetration was quite sufficient to ensure the desired difference in the depth of carburisation, and one operation only was needed to do the job.

Many interesting experiments on hardening articles which could be subsequently broken to show the fracture were carried out for our inspection. In one of these a large wire nail, about 6 in. long, was coated with the paste and put in the furnace at 950 deg. C., for exactly 15 minutes. When removed, quenched and broken a quite definite case, as distinct from a mere skin, was observable, the thickness of carburisation being quite 0·02 in. Steel bushes were hardened, some on the inside and some on the outside, the square hole inside a thick washer was hardened, as also was a nickel steel ball race.

The rapid action of the Carbonex paste is said to be due to the formation of an active cyanide at the furnace temperature, the nitrogen of which has a catalytic action on the carbon and promotes its activity. We were shown the processes of manufacture of the material at the works of the company in North London, and the care taken to ensure the uniformity of the product, and the consistency of composition of the different batches. Besides the Carbonex paste the company also manufacture a case-hardening powder with which equal care is taken. This is not so rapid in action as the paste, and is suitable for articles which have to be packed in boxes in the furnace.

The price, moreover, of both the powder and the paste is very moderate as compared with many of the compounds on the market. Comparative tests were made in our presence of the results of hardening five pieces of Ubas case-hardening steel in different compounds, and the results appeared to confirm the claims made for the new materials. Incidentally, in connection with these and other experiments which we were shown, the enormous importance of proper heat treatment of articles after case-hardening by any method was demonstrated. The practice of the company at whose works the tests were carried out, is to give a double heat treatment to every article after carburising, the first to refine the structure of the core and the second to eliminate the free cementite in the case, which is the cause of flaking and chipping under wear of surfaces subject to shocks.

"DOUBLE-REDUCTION GEARS FOR TURBINES."

To the Editor of Engineering.

Sir,—It is evident that Dr. Hatfield and myself agree generally speaking, as to the abnormal conditions under which the gear pinions may have to do their work, but I cannot agree with him when he says that no steel exists capable of standing up to these conditions. I consider that pinions can be supplied which would give as long a life as the wheels, whatever the conditions may be.

Dr. Hatfield's views seem to be that the required steel should be soft enough to admit of plastic deformation under excessive stress, but my opinion is that this would lead to failure through fatigue before the deformation had proceeded far enough to cause the teeth to bear uniformly through the greater part of their length, and so ease the local stresses.

My opinion still is that a harder tougher steel is required, one which will stand up to its work until the natural wear between the teeth (in this case mostly on the wheel teeth) eases conditions, and reduces the local stresses. During the last three or four years, we have supplied nearly 200 nickel steel pinions to different firms for marine turbines. No doubt the greater number of these have been in service for a considerable time, and up to the present, we have not been notified of any cases of failure, and we have no reason to suppose that our pinions have received any preferential treatment in machining. But in view of the general trouble with nickel steel pinions, we consider it advisable to have a greater margin of safety, and in all cases, recommend the "Vibrac" pinions with their higher elastic limit and impact figures as likely to give a much longer life under all conceivable conditions.

Might I present to those interested the two stress strain diagrams herewith. No. 1 is one of the diagrams printed in your issue of September 1, and would appear to meet Dr. Hatfield's views as to plastic deformation, and yet, it failed badly in service. No. 2 is a nickel steel pinion of our make, which we think may be taken as representing the maximum that can be obtained from this material, but which would form a good basis for fixing the minimum mechanical and physical properties of a steel such as "Vibrac." These two diagrams will illustrate what variation there may be in the pinion in use, and I am gratified to learn that there are others who entirely concur with my views on the subject.

Yours faithfully,

Wm. C. Rowden.

(Sir W. G. Armstrong, Whitworth and Co., Limited.)

Ashton-road, Openshaw, Manchester,
October 24, 1922.

To the Editor of Engineering.

Sir,—With reference to the letters which are being published in your paper with regard to the subject of double-reduction gears, might we be permitted to outline the position we have arrived at as a result of our investigation of this question. We also append a specification of the properties which we consider steel should possess in order to meet the very severe conditions which apparently are met with in service.

An investigation of teeth which have failed in service show that the failures have been due to the material having been overstressed; in no case have we found that the stresses have been localised, due to local weakness occasioned through non-metallic inclusions or through hair line cracks developed during treatment.

We wish to place on record the fact that, in our experience, the failures have not been due to steel.

Engineers state that the workmanship in these pinions is of the highest and that the degree of accuracy attained,

being within thousandths of an inch, cannot be improved on.

Combining our experience of steel and the engineers' record of workmanship, we have formed the opinion that the teeth in first reduction gearing are more highly stressed than is shown by calculation.

Nickel steel has only a moderate elastic limit and only a moderate degree of toughness and, as will be shown later, under shock and vibration is relatively weak, due to the fact that the crystals do not accommodate themselves readily under instantaneous shock to the altered conditions, and hence, when broken, show a crystalline fracture, while some other types of steel respond quickly to those conditions and when broken show a fibrous fracture.

If the conclusion we have arrived at is correct, then it is undoubtedly necessary that the steel maker produces the highest class of material. The properties we consider necessary for this purpose are :—

1. Toughness.
2. High true elastic limit.

We place toughness first, as, in our opinion, this is the chief property steel should possess in order to resist shock, vibration, &c.

No satisfactory definition of toughness has yet been evolved, but the sense in which we use it is that property of steel by virtue of which it can successfully resist fracture under shock.

The test usually adopted as a measure of this factor is the Izod, but we suggest the following in preference to it, *i.e.*, the test bar is notched all round by a 90 deg. V, sharp at bottom; the falling weight is considerable and the velocity at point of impact is high, so that the energy developed is so great that no appreciable deformation of the crystalline grains takes place during breaking.

Photograph No. 1 illustrates the fracture of nickel steel as used in pinions.

Photograph No. 2 illustrates the fracture of steel having nickel chrome as base and which is used in pinions.

Nickel steel as used in pinions has a true elastic limit of approximately 22 tons to 24 tons per square inch, and when broken under the conditions outlined, has always a crystalline fracture.

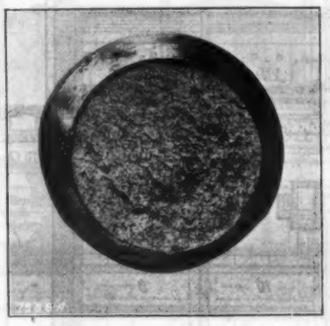


FIG. 1. Fracture of Nickel Steel as used in Pinions.

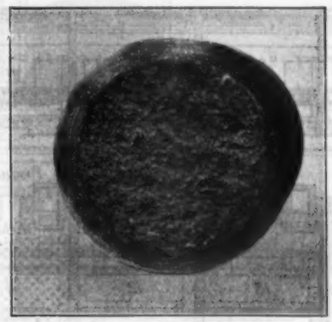


FIG. 2. Fracture of Steel, having Nickel-Chrome as Base, as used in Pinions.

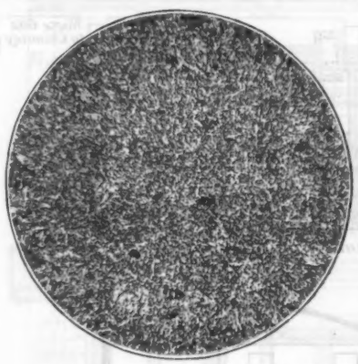


FIG. 3.* Structure of the Surface of a Nickel Steel Pinion.

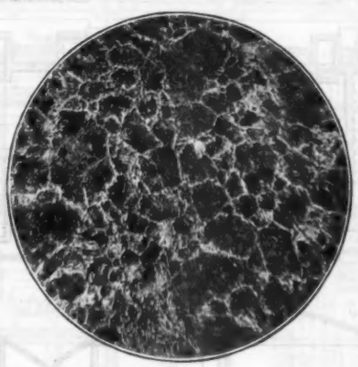


FIG. 3A.* Structure of the same Pinion as Fig. 3, 4½ in. from the surface.

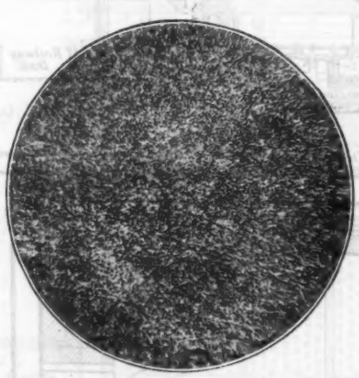


FIG. 4.* Structure of the Surface of a Steel Pinion with a Nickel-Chrome Base.

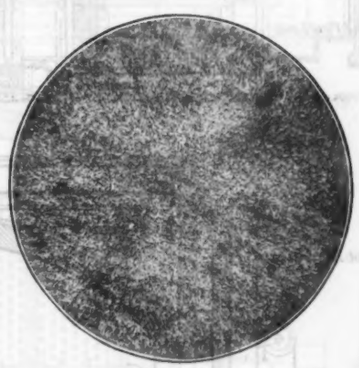


FIG. 4A*. Structure of the same Steel as Fig. 4, 4½ in. from the Surface.

* THESE FIGS. ARE REPRODUCED FROM PHOTOGRAPHS HAVING A MAGNIFICATION OF 100; PRESENT SCALE MAGNIFICATION OF 80.

Steel with nickel-chrome as base has a minimum true elastic limit of 30 tons per square inch and, when broken under the conditions outlined, has always a fibrous fracture.

The structure outlined in photograph No. 2 is due to :—

(*a*) The material possessing a very small crystalline grain.

(*b*) The carbon being uniformly diffused throughout the mass.

Photograph No. 3 illustrates the structure of the surface of a nickel steel pinion.

Photograph No. 3A illustrates the structure of the same pinion 4½ in. from the surface.

Photograph No. 4 illustrates the structure at the surface of a steel pinion with a nickel-chrome base.

Photograph No. 4A illustrates the structure of the same steel as 4, but 4½ in. from the surface.

The specification we have provisionally outlined for this steel is :—

	Length.	Transverse.
True elastic limit	30 tons	30 tons
Ultimate tensile strength (minimum)	50 tons	50 tons
Elongation on 2 in.	20 per cent.	15 per cent.
Contraction of area	50 per cent.	35 per cent.
Bend, 1 in. square	180 deg. over ¾ in. radius	¾ × ¾ 180 deg. over ¾ in. radius
Izod	45 ft.-lb.	30 ft.-lb.

We have inserted the Izod test as it is the customary one, but in practice the method of breaking should be strictly defined, *i.e.*, the position of the notch should be at right angles to the outside surface.

From the brief outline we have given and from the specification included, it will be seen that only a limited type of steel is possible, and that this must be of the highest class.

Yours faithfully,
T. M. SERVICE.

Parkhead Steel Works, Glasgow,
October 23, 1922.

SWEDEN.—We have received from the Swedish Consulate General in London, a publication entitled "A Book about Sweden," which is published by the Swedish Traffic Association. It is admirably printed and illustrated, it gives numerous maps, and in a small scope contains a large amount of information on the country. This information covers the geography and history of Sweden, its commerce and industry, and includes particulars for the aid and guidance of both tourists and commercial firms. The chapters on the various Swedish industries point to a marked degree of perfection in every speciality dealt with in the country. The book is most interesting and reflects great credit upon its publishers.

"CATALOGUES FOR FOREIGN COUNTRIES": ERRATUM.—In ENGINEERING of the 13th inst. (page 470) a letter appeared under the heading of "Catalogues for Foreign Countries," in which our correspondent said: "To return to the Lyons' Fair, however, I think that the most optimistic exhibits in the whole of the fair were two glazed bricks of English manufacture, each bearing a label in English to the effect that the bricks were only samples as regards size and colour and the manufacturer did not guarantee that *any* bricks supplied would be equal in quality to the two samples." We have received a copy of the label that was attached to the bricks in question, and from this we learn that the word "any," which we have just given in italics, should be "all." The error in the letter alters the meaning of the label, and we regret that the mistake was made.

THE OPTICAL SOCIETY.—The programme of the society for the current session includes the following lectures dealing with the evolution and development of optical instruments and apparatus: "The History of the Photographic Lens," by Dr. R. S. Clay, on November 9; "The Birth of Cinematography and its Antecedents," by Mr. Will Day, on January 25, 1923; "Surveying and Nautical instruments from a Historical Standpoint," by Dr. L. C. Martin, on March 22; and "Telescopes from a Historical Standpoint," by Mr. D. Baxandall, on May 24. The lectures will, in each case, be illustrated by a series of unique instruments of historic interest from various collections. The meetings will be held at 7.30 p.m. on the above dates at the Imperial College of Science and Technology, South Kensington.

UNITED STATES EXPORTS.—The United States is leading the world in the value of sales to foreign markets, says *Commercial America*, Philadelphia. The value of American exports in the first six months this year amounted to 1,820,000,000 dols., or 16 per cent. more than the shipments of England, long known as the leading export nation. British exports were valued at 1,565,000,000 dols. at the current rate of exchange. It should be noted in this connection that the United States is exporting manufactured goods in greater quantities than raw materials in comparison with pre-war standards. In fact, this tendency has been largely responsible for the maintenance of the country's large export trade. Another factor is that Germany's "underselling" world campaign to gain trade is not proving as serious to exporters of the United States as it had first been supposed. It seems that in many cases German manufacturers have been unable to make deliveries promptly to meet the needs of the market. In other cases, the quality of merchandise supplied for the low prices quoted has not been up to standard expected.

A NEW FORM OF KILN FOR BURNING FIREBRICKS.

Fig. 1.

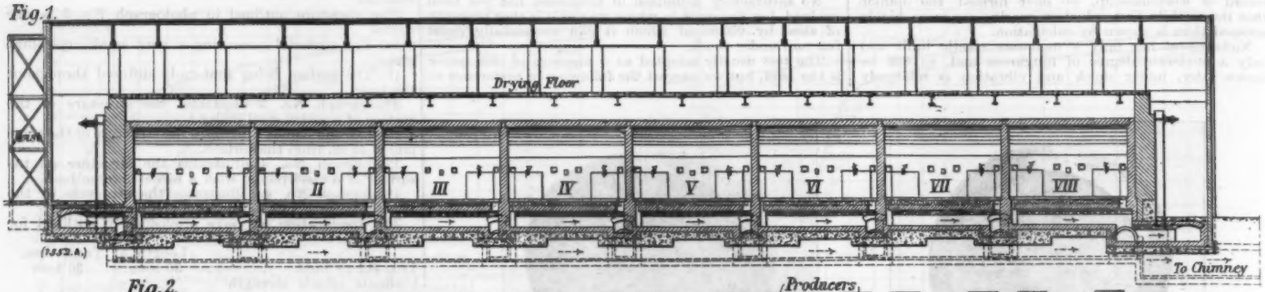
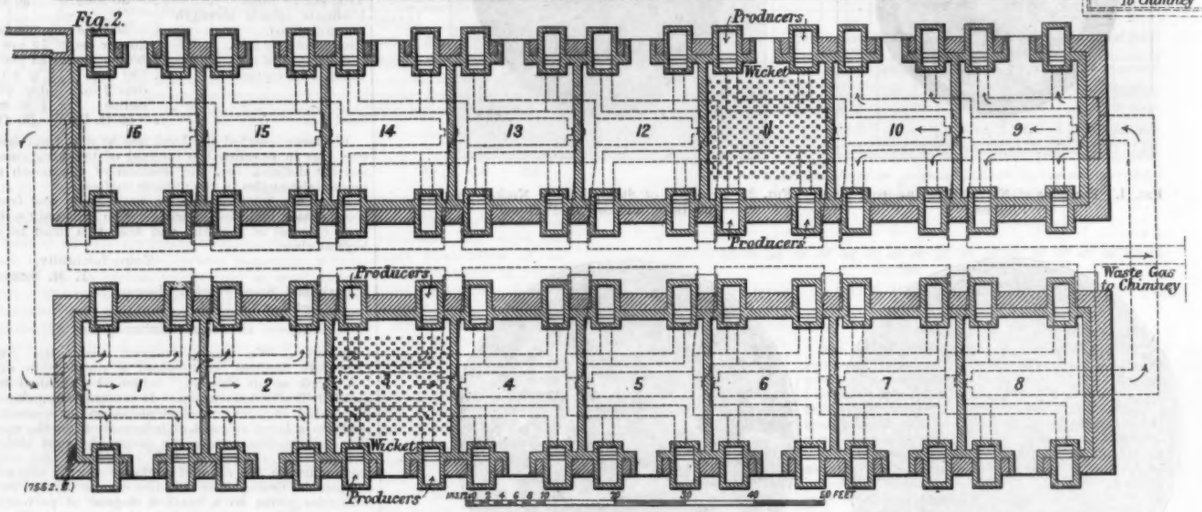


Fig. 2.



SOME NEW FORMS OF KILNS.*

By Sir Arthur Duckham.

At the last autumn meeting of this section of the Ceramic Society, I promised Dr. Mellor I would place before you some designs of kilns which presented novel features. Although some of these are not specially adapted to refractory work, they may interest you and will show the line of thought followed in our designs. My firm, as you may know, were primarily interested in the construction of plants for the manufacture of coal gas. We required for our purposes large quantities of high-class refractory material. The temperatures we wanted in the combustion chambers around our retorts were considerable—1,350 deg. C. In the earlier stages we had the greatest difficulty in obtaining suitable material, in fact, we suffered heavy losses through the failure of the materials used. But for these circumstances we probably should not have taken up research into, and manufacture of, refractory material.

In 1914 we were instrumental in the formation of a firebrick manufacturing company, and undertook the design of a kiln that would ensure the proper burning of our refractory materials, together with a due economy of fuel. We were already closely in touch with the manufacturers in the Stourbridge area, and it was in that district we placed our works. The design of the kiln we erected was based on an existing plant in Germany, in the works of our agents, and during eight years has given general satisfaction. The kiln is of the continuous type, 16 chambers in all, each chamber 19 ft. 1½ in. wide by 16 ft. 9 in. long by 6 ft. high to springing of arch, and 10 ft. 5 in. high to the crown of the arch. The chambers are arranged in two lines, with wickets on the outside only. There are four fireholes and bags to each chamber, the arrangement of firing being that generally known as semi-gaseous. The chambers are connected by flues under the floor, for the passage of secondary air and heating gases.

The heat in goods already fired is utilised by passing the secondary air for combustion through several chambers behind the one being fired, and the products of combustion from the firing chamber travel through several chambers ahead, preheating the goods to be fired, before passing through the damper to the waste gas flue and chimney. Figs. 1 to 4 show the general lay-out of this type of kiln.

One of the chief questions in design was to settle whether to heat the kiln by an outside producer or by four individual fireholes to each chamber. In Germany the outside producer was used, consuming brown coal. We adopted the individual firehole system as we felt that the advantage of getting hot gas to the point of combustion in the bags would make up for the disadvantages attendant to individual fireholes. The results of working

* Paper read before the Refractory Section of the Ceramic Society, at Birmingham, October 3, 1922.

Fig. 3.

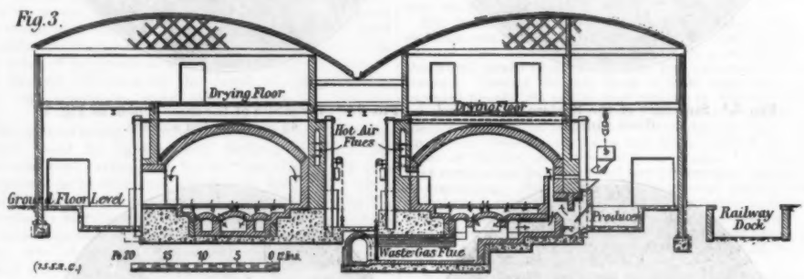
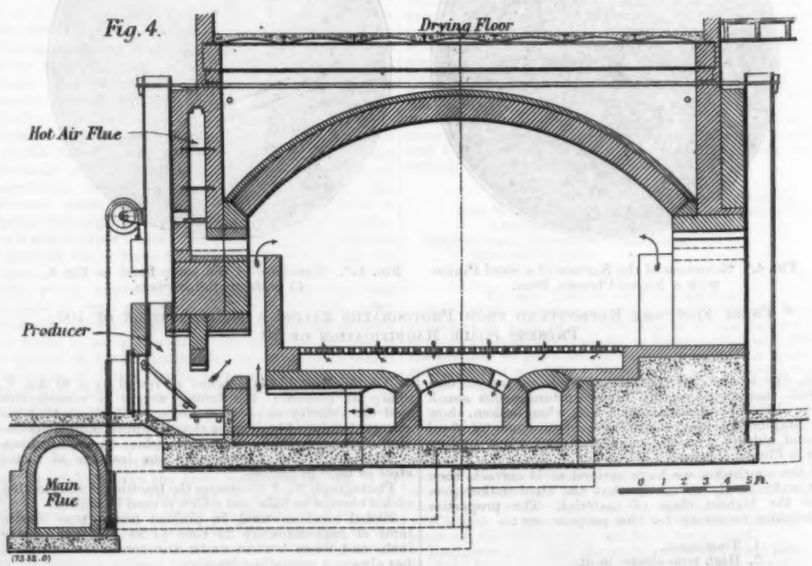


Fig. 4.



have justified our decision, and for this form of kiln with individual bags and down draught the firing arrangement adopted gives excellent results.

We burn firebricks in this kiln, made of local clay and reinforced with clay grog and silica. The bricks are burned till cone 13 comes down in the centre of the material, and this temperature is held for about 12 hours. Each chamber holds 60 tons of material, and we burn 14 to 15 chambers per month. The fuel consumption is 20 tons to 25 tons of coal per 100 tons of material burned.

I would now put before you the disabilities of this kiln as constructed. The chief trouble we had was to obtain sufficient draught to be able to work two chambers ahead of the firing kiln in order to utilise the heat in the flue gases and two chambers behind to heat the secondary air properly. The chimney was 180 ft. high, but as the temperature of the flue gases was only 120 deg. F., entering the chimney, the pull on the main flue was insufficient.

The low temperature of the flue gases entering the chimney was partly due to the full utilisation of their sensible heat in the chambers ahead of the firing chamber, and partly due to air leakages chiefly through the main dampers to each chamber. The dampers, as you will have noticed in the diagrams, were of the vertical cast-iron type, and it was found impracticable to keep these air-tight either around the sides or at the top. Consequently these dampers were replaced by cast-iron flap doors. This change ensured tightness at this point, and greatly improved the draught. We still found, however, that we could not under all weather conditions be certain of obtaining in a reasonable time and under all conditions the high temperature of burning which was absolutely essential in order to ensure that the shrinkage had been eliminated from the firebrick material. We consequently decided to dispense with natural draught altogether, and installed artificial draught with most satisfactory results. The output from the kilns is greater, and we can be sure of the proper burning of the material. Recent tests on the product of this kiln show a shrinkage of between 0·25 per cent. and 0·75 per cent. when heated for 2 hours at 1,410 deg. C. actual.

Another difficulty we had to meet is inherent to the principal of a down draught kiln. The material at the top was burned to a higher temperature than the material at the bottom, and if the bottom temperature was raised to a proper degree there was grave danger of the upper material being damaged. As we proposed to extend the output of this works we had to consider and overcome this difficulty and had to decide to depart from the principle of either an up-draught or down-draught kiln.

Figs. 5 to 10 show what we call the W.D. central bag kiln. Dr. Mellor has put this kiln previously before you and it will therefore need but short description. Its advantages are: (1) That even heating is obtained throughout the whole of the material of the kiln; (2) That the bag forms no portion of the kiln proper, and so can be made of different material, and further it can be easily renewed; (3) Proper combustion of the heating gases is assured; (4) the brickwork forming the kiln proper is never subjected to the direct action of the heating gases during combustion.

A single chamber, 15 ft. 2 in. wide by 16 ft. 8 in. long by 7 ft. 6¼ in. to the springing of the arch and 10 ft. 9½ in. to the crown of the arch, has been constructed on these principles with an outside producer burning coal and has given satisfactory results. We are shortly erecting a continuous chamber kiln on these lines. Such an arrangement is shown in Figs. 5–10, giving general arrangement and details of 10 chamber kilns of the continuous type, arranged in two blocks with central producer at one end. The distributing producer gas flue is underground in the centre and the waste-gas collecting-flue underground on the outsides, connected to a fan at the opposite end to the producer.

Connection is made between the producer gas flue and firing chamber by a portable bridge pipe which is moved from one chamber to another according to the rate of firing. A similar connection is provided between the chambers and the waste-gas flue to the fan. The chambers are connected by flues under the floor and the utilisation of the waste heat is effected in the same manner as described in the chamber kilns, shown in Figs. 1 to 4.

The high temperatures necessary for the proper burning of refractory material and the comparatively long period of soaking required at that temperature precludes to a great extent the use of other types of kiln than the continuous chamber for this purpose. In fact, for the burning of silica material, where an even higher temperature of firing and a longer period of soaking are essential, further modifications in continuous kilns must be made to obtain satisfactory working. We are at present designing a special kiln for burning silica bricks, and when these designs are completed I trust an opportunity may occur for them to be put before you.

The type of kiln which has always attracted the designer is the tunnel type. This type has not proved satisfactory for the burning of refractory material, but I venture to put before you two modifications of this type as I believe consideration of them may interest you and may lead to further developments.

The advantages of a tunnel kiln are very evident—saving of labour and fuel and even heating and cooling of the materials. The disadvantages are:—

(1) Mechanical.
(2) The great length of the tunnel.
(3) The tendency of the heating gases to rise, and so cause uneven burning.

Dealing first with the open type of tunnel kiln (Figs. 11 to 14), we have endeavoured to overcome these difficulties in the following ways:—

Instead of allowing the gases to pass straight through the whole length of the kiln, cross walls are provided on each truck carrying the material, these cross-walls registering with offsets on the kiln walls, thus forcing the gases to take a zig-zag path instead of a straight one. By this means we are able to reduce the length of the kiln from, say, 300 ft. to 130 ft. These cross-walls really divide the tunnel up into a number of chambers, short flues in the side walls being provided to carry the gases from one chamber to another. In order to ensure the material heating throughout its height when piled on the truck, the openings for the passage of the gases

Fig. 5. SECTION A-B.

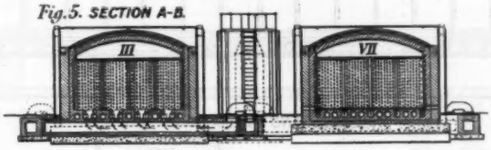


Fig. 6. SECTION E-F.

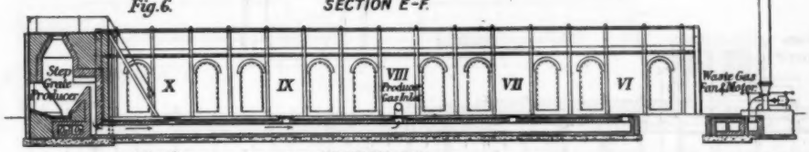


Fig. 7. SECTION C-D.

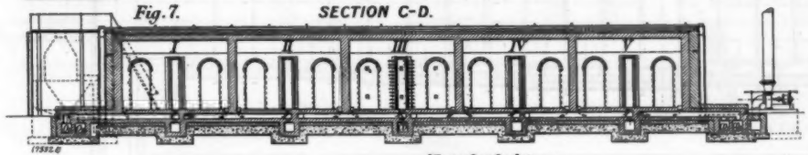


Fig. 8.

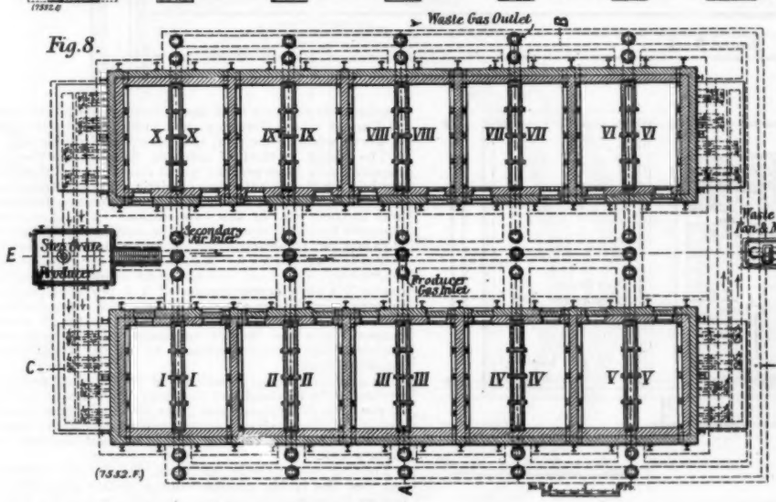


Fig. 9.

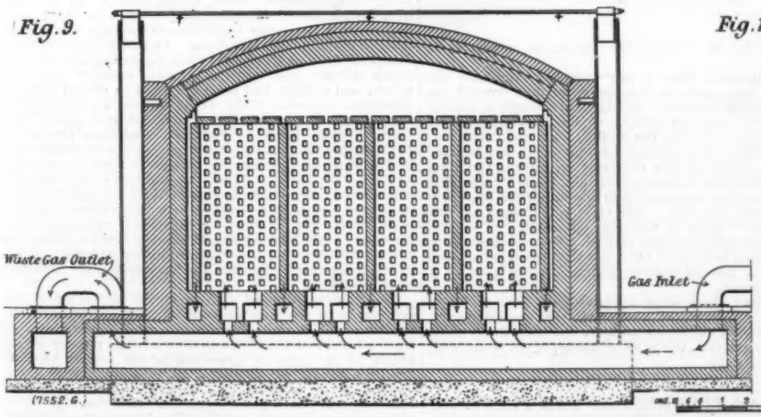
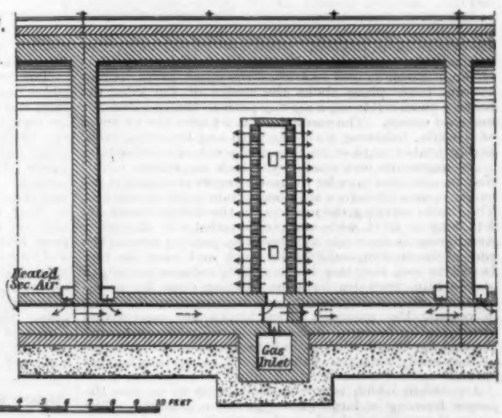
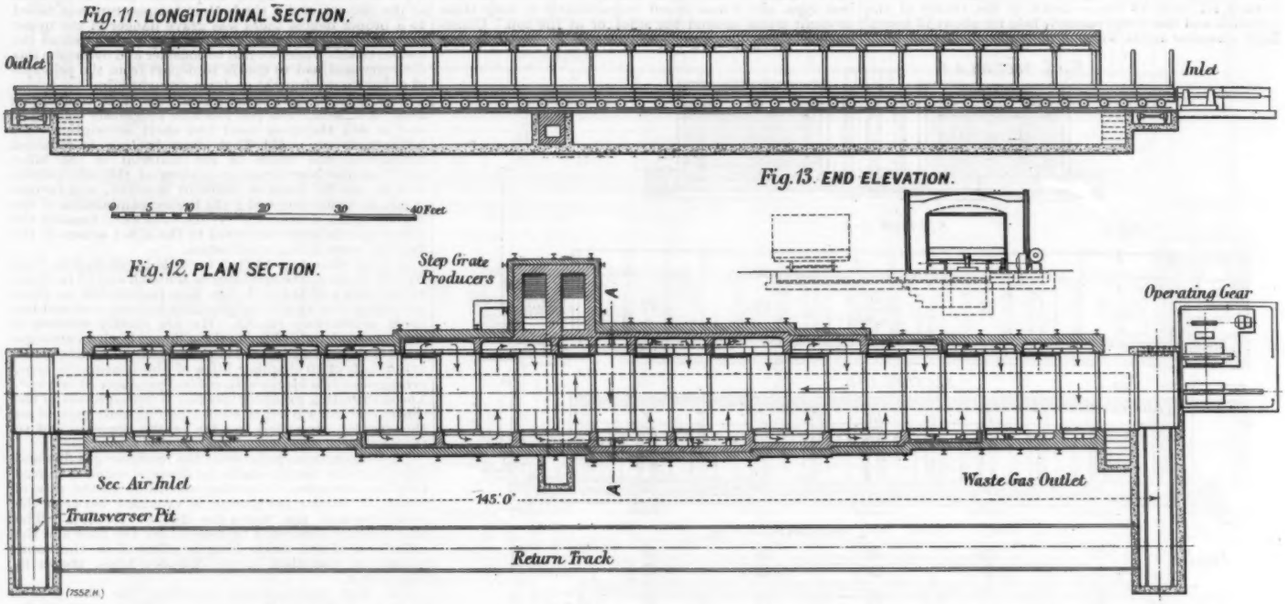
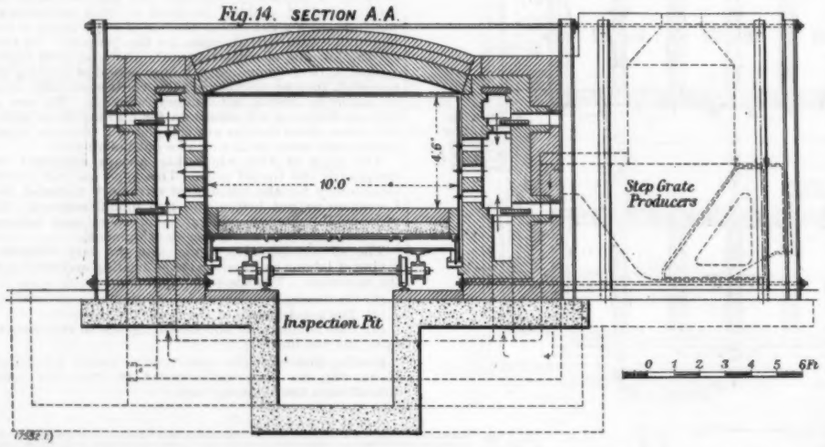


Fig. 10.



A NEW FORM OF TUNNEL KILN.





are only made in the lower portion of the flue walls, thus ensuring the heating gases flowing across the lower parts of the material as well as around the upper parts. Combustion takes place about the centre of the kiln, the heating gases following a zig-zag path to the end that the material enters. The cooling air is let into the exit end of the kiln, following a zig-zag path and becoming more highly heated until it reaches the point of combustion.

Arrangements are made by which an excess of air may be admitted in order to ensure proper cooling and the excess drawn off before the combustion point is reached. The trucks carrying the material in the design shown are 5 ft. long by 10 ft. wide and are travelled 5 ft. at a time. Arrangements are made to prevent by-passing around the ends of the division walls on the truck and over the top. It will be seen that this design greatly reduces the length of the kiln, provides for even heating over the cross-sectional area of the tunnel, and removes any difficulty in cooling the material. The trucks are sand-sealed about at the bottom, and a ventilated pit is provided through the length of the kiln beneath the truck bottoms, so that ready attention can be given to any mechanical part.

A problem which was recently put up to us was the proper burning of large glazed goods in a muffle. The material was to be slowly and evenly burned at a temperature of about 1,100 deg. C., and slowly and evenly cooled. For this purpose we designed an annular, circular tunnel kiln (Figs. 15 to 18), with the heating gases muffled. The continuity of the tunnel is broken at the unloading and loading point, but the annular fire-brick tray carrying the material is continuous and unbroken. The heating of the kiln is by means of producer gas burned in six horizontal flues arranged one above the other in the side walls of the tunnel. These flues being separated throughout their length, the intensity of heat to the various parts of the kiln is controllable, and an even temperature preserved through the height of material. The tray is moved by electric motor and gearing 10 ft. at a time, the operation taking some 30 seconds.

The combustion zone is approximately opposite the unloading zone, and the heating gases flow toward the inlet end for the material. Mechanical draught is applied by means of a fan and motor. Cooling is controlled by the admission of air into the muffled flues about the outgoing material, and a regulated supply of air is admitted inside the muffle at the exit end to ensure the final cooling. Special arrangements are also made for warming and removing the moisture from the unburned materials as they enter the kiln. The chief advantages of this kiln are convenience of working, elimination of trucks, even heating and economy of fuel. One of these kilns will be working early next year, but the principle has been proved on a kiln of similar design forming part of a chemical process.

In designing these kilns we have tried first of all to grasp the fundamental needs of the manufacturer. These, of course, vary very greatly, but once these needs are fully understood, the work of design is not so difficult a matter.

POST-WAR PROGRESS IN THE FIXATION OF NITROGEN.*

By Dr. J. A. Harker, F.R.S.

Remarking at the outset that the technical literature on nitrogen originated largely from prejudiced sources, Dr. Harker acknowledged that attention had been drawn by a Berlin firm to the Report of the Nitrogen Products Committee because a competent authority had there set out the advantages and disadvantages of the various processes without prejudice. His own attitude was to regulate his conduct as if there were a hole in the map of Europe, where Germany used to be; but he thought it worth while to mention this unexpected testimony.

The oldest method of nitrogen fixation by the arc required very large power; yet it remained the cheapest method for the manufacture of nitric acid. At Notodden 45,000 kw. were utilised in Birkeland-Eyde arc-furnaces, and 200,000 kw. in the two stations at Rjukan, the cheapest hydro-electric plant of the world; at Rjukan II a 15,000-kw. steam-operated set had now been added to utilise the waste steam. As less than 2 per cent. of the heat energy expended was absorbed in producing nitric oxide NO at a concentration of 1·2 per cent. in the furnace gases, many alternative forms of furnaces had been tried; among these 14 plants, mostly of small outputs, was the 300-kw. experimental plant on the Kilburn-Scott system erected at some Birmingham munition works.

In some of the new variants of the original process, worked in Switzerland and Germany, air was enriched to 50 per cent. of oxygen; the gases circulated in a closed circuit and the product was removed by cooling as liquid peroxide NO_2, but several explosions had occurred in these works.

Turning to synthetic ammonia, Dr. Harker pointed out that the Haber process worked at 200 atmospheres in very large units at low gas velocity, the reaction tubes being large flanged steel tubes, nearly 40 ft. long, over 3 ft. external diameter, with walls 6 in. thick; the preheated gases were recirculated through the system after removing the ammonia. The Nitrogen Products Company had, at University College, during the war used much higher gas velocities with greatly increased yields, and a plant had been designed to obtain 5 kg. of ammonia, instead of the 400 grammes of the original German plant, per hour per litre of catalyst space. The United States plant at Sheffield, Alabama, erected in 1917–18 and planned for 11,000 tons of nitrogen annually, had worked on lines similar to the German process, but had used activated sodamite as catalyst; that product was difficult to prepare, and its activity was permanently destroyed by small quantities of water vapour, and the plant had not reached commercial operation. An improved plant of the General Electric Company and the Solvay Process Company was producing liquid ammonia, at the daily rate of 10 tons, for the refrigerator industry, near New York.

The Claude process* differed from the older Haber process by a working pressure of 900 atmospheres, by means of which was obtained a combination ratio of 40 (instead of 10 or 11) per cent. after a single passage giving about 25 per cent. of ammonia in the issuing stream; the litre of catalyst yielded 5 kg. of ammonia per hour. Multiple-stage working was adopted instead of re-circulation, and the dimensions of the 5-ton plant (per day) were almost absurdly small. The latest catalyst tubes, which Dr. Harker had seen at the Montereau works, were made in Sheffield.

The hydrogen for the plant was to be isolated from coke-oven gas. The cost of the hydrogen preparation and purification was always of paramount importance; it amounted to 65 per cent. or 70 per cent. in the works of the Badische Company.

In the Casale process, in use at Terni, near Rome, the hydrogen was generated electrolytically, with the aid of the hydroelectric power of the waterfalls; some of this

* Summary of an Address delivered before Section B (Chemistry) of the British Association at Hull on September 12, 1922.

* *c.f.* "The Claude Synthetic Ammonia Process," Engineering, November 25, 1921, page 732.

CIRCULAR TUNNEL KILN FOR GLAZED WARE.

(*For Description, see Page 534.*)

Fig. 15. SECTION B.B.

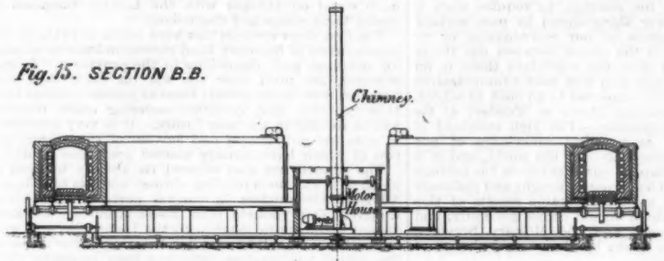


Fig. 16. SECTION A.A.

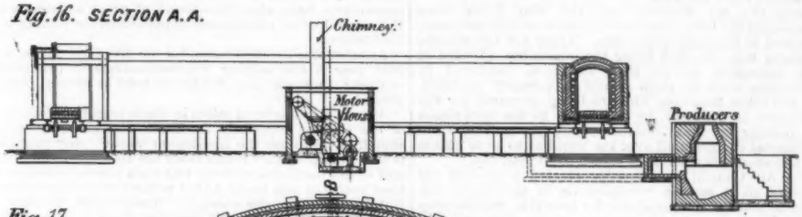


Fig. 17.

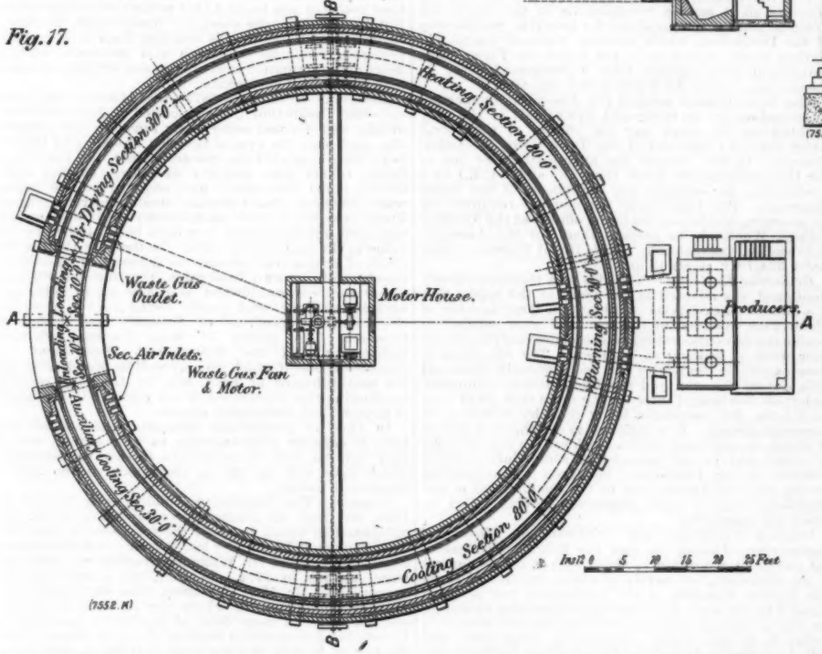
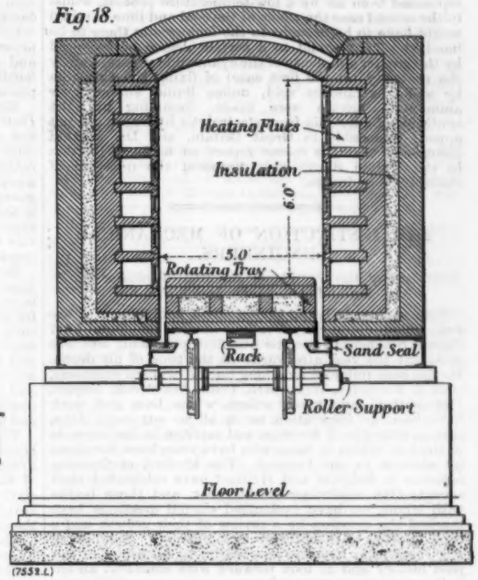


Fig. 18.



hydrogen was burnt with air, leaving the hydrogen-nitrogen mixture wanted for the ammonia synthesis. Much attention was being paid to new types of electrolysers, particularly in Switzerland and America, and with the high prices of coke, this battery-hydrogen produced from cheap hydroelectric power would be well able to compete with other hydrogen, if the battery plant costs could be reduced.

The calcium cyanamide (nitrolim) process, sometimes considered obsolete or, at any rate, obsolescent, had at the end of the war commanded plant of greater nitrogen capacity than any other fixation method; but some of the war works had been closed when the nitrogen was wanted as fertiliser, and no longer for ammunition. Thus the largest cyanamide works of the world (annual capacity 200,000 tons), erected at Muscle Shoals, Alabama, by the American Government, were not in operation, and it was uncertain whether the Government would lease it to some firm or keep it, like the Sheffield plant in readiness for the next war.

Including the expenditure on an unfinished plant, scrapped after the armistice, America had spent 140,000,000 dols. on nitrogen fixation. On the other hand, the capacity of the Caro-Franck cyanamide plant at Presteritz was to be doubled. There had been no development of outstanding importance in the manufacture of cyanamide; it remained the cheapest form of combined nitrogen. Yet it was an unsatisfactory fertiliser for many soils, as it was apt to turn (by polymerisation) into dicyandiamide.

For that reason many attempts had been made to transform the calcium cyanamide nitrogen into some other compound, for instance, into ammonium sulphate, so far mostly with little success. One of these products, the American mono-ammonium phosphate (the ammophos of the trade) was promising, though expensive. Within the last year, however, calcium cyanamide had been decomposed in Sweden and Switzerland, by the aid of carbonic acid into free cyanamide, which was then converted into urea, and calcium carbonate. In the second stage of the process Swiss chemists used an excess of sulphuric acid which, subsequently acting on natural phosphate, gave a mono-phosphate. The final product known as phosphazote contained its nitrogen as urea and its phosphorus in the water-soluble form. This product, which did not spoil the bags nor irritate the skin, as calcium cyanamide might do, had for six months been used in the French vinyards. The old cyanide processes (fixation of the nitrogen of animal refuse as prussiate by fusion with potash in the presence of iron) was also being reinvestigated in its various modifications. The Bucher process seemed too expensive; in America cyanamide was decomposed to yield hydro-cyanic acid (utilised for plant fumigation), and experiments were also made in Birmingham. The mixed salts containing ammonium nitrate and sulphate, which had caused the Oppau explosion—the damage from which had since been repaired—were probably perfectly safe and would then have been, if the removal had not been attempted of the hard caked salts by means of big blasting cartridges.

Dr. Harker concluded with a solemn warning. According to Professor Matignon, of the Collège de France, the smaller Germany of to-day had consumed, in the year ending last April, 290,000 tons of nitrogen (that being 45 per cent. more than in 1913), without satisfying the demands of her agriculturists;* and that total had been produced within the country, and not half imported from Chile. The plants were not worked to their limit of capacity, moreover. It might be justifiable for the Allies to allow their late enemies to put themselves into so strong a position so soon after the war, whilst Gretna and almost all our munitions works were being dismantled; but let them beware.

* These figures do not differ much from the recent statistics of J. Hess ("Electric Energy for Chemical Purposes," *Elektrotechnische Zeitschrift*, July 28), who further points out that the nitrogen equivalent of stable manure had decreased by 260,000 tons in the period 1913 to 1919, and the imports of phosphates from 630,000 tons of P_2O_5 in 1913 to 268,000 tons in 1920.

SOME ASPECTS OF THE RELATIONSHIP BETWEEN WATER POWER AND NITROGEN FIXATION.*

By E. B. MAXTED, D.Sc., Ph.D.

THE fixation of nitrogen by any of the three principal processes, Dr. Maxted stated, involved two economic factors, which might conveniently be grouped under the headings of power and of materials. The predominance of the one or the other would determine the site and the process suitable to local conditions. Under British conditions, apart perhaps from the manufacture of nitric acid as such, only the manufacture of calcium cyanamide and the direct synthesis of ammonia were economically possible. The potential resources of water power in Great Britain had recently been estimated, by the Water Power Resources Committee of the Board of Trade at 250,000 kw., mostly located in Scotland; this estimate was exclusive of the Severn Estuary scheme. Of the 10 Scottish sites, favourably reported on, only one would produce over 30,000 kw. and only two over 20,000 kw.; the total available power of these 10 sites was about 100,000 kw. In Wales five sites were reported on favourably, only one of more than 5,000 kw. But plants of less than 10,000 kw. were not considered suitable for the economic production of calcium carbide or cyanamide. Thus hydroelectric power for these purposes would principally be available in Scotland, where the cost would be about 30*l.* per kilowatt on the pre-war basis. Operating and other costs would be low, amounting perhaps to 3 per cent. on the installation capital, and it should under present conditions be possible to produce the kilowatt-year for about 4*l.* 5*s.*

Taking 5*l.* and 135 kw.-hours per 1,000 cub. ft. of electrolytic hydrogen—a figure obtained in practice—the power cost per 1,000 cub. ft. of hydrogen should be ½*d.*, disregarding the value of the oxygen also produced by the electrolysis. Even allowing for other expenses, this ½*d.* would not compare unfavourably with the cost of hydrogen from fuel, which could not sink below 2*s.* per 1,000 cub. ft. In Germany the conditions necessitated the production of hydrogen from fuel; but for our country a strong case could be made out for electrolytic hydrogen, in spite of the relatively large battery floor space and the multiplicity of the cells required. Large cell units for high current density were being developed, and the oxygen would be utilised.

Examining the problem from a slightly different aspect Dr. Maxted assumed that the 10,000 kw. available could be completely utilised. Firstly, for making synthetic ammonia. About 5,500 tons of nitrogen could be fixed per year as ammonia. 8,000 kw. (of the 10,000)

* Summary of a paper read before Section B of the British Association at Hull, September 12, 1922.

being used for the electrolysis, 1,000 kw. for compression to 200 atmospheres, and the remainder for other purposes. Secondly, for making calcium cyanamide. The weight of the fixed nitrogen would be about the same. But 35,000 cub. ft. of waste oxygen would be available per hour in the first case, assuming the nitrogen to be separated from air by a low-temperature process, whilst in the second case the whole of the coal and lime required would have to be brought to the factory site there to be handled. That would to a certain degree be balanced by the greater simplicity of the cyanamide process and by the necessity (in the first case) of fixing the ammonia by some extraneous acid, unless liquid ammonia or ammonium nitrate were made. Summing up, the synthesis of ammonia from electrolytic hydrogen did not appear impossible in Great Britain, and Dr. Maxted mentioned that the recent report on nitrogen fixation in the United States also discussed the question of electrolytic hydrogen.

THE INSTITUTION OF MECHANICAL ENGINEERS.

Address* by the President, Emeritus Professor H. S. Hele-Shaw, LL.D., D.Sc., F.R.S.

The year 1922 is the seventy-fifth anniversary of the foundation of our Institution, as in the year 1847 George Stephenson became our first president, and was president the year afterwards at the time of his death. He has been followed by a long line of eminent engineers, such as Fairbairn, Whitworth, Penn, Armstrong, Napier, Ramsbottom and many others, whose lives and work have been an inspiration to us all in our early days, and an example of devotion and sacrifice in the interests of the Institution to those who have since been honoured by election to the Council. The kindred engineering societies in Belgium and Holland have celebrated their seventy-fifth anniversaries this year, and those bodies with whom we have exchanged cordial greetings have marked the occasion by a review of their growth and a consideration of their future development. Members of our Institution have no less reason to be proud of our past history and to look forward with confident anticipation to an even greater future.

Education.—The addresses of former presidents have covered a wide range of subjects, since a very excellent custom has generally been observed by each different president of dealing with the particular branch of mechanical engineering with which he has been specially connected. In many cases, however, there is one subject intimately associated with the welfare and growth of our Institution, which has been dealt with by former presidents, namely, the education of a mechanical engineer. It so happens that my own work, after my apprenticeship and employment in works and until twenty years ago was, like that of two of my distinguished predecessors, Sir Alexander Kennedy and Dr. Unwin, that of a professor of engineering. Having had the experience, shared, I believe, only by Sir Alfred Ewing, former member of council, and now principal of Edinburgh University, of being first professor of three schools of engineering, all now universities—in my own case these being Bristol, Liverpool and Johannesburg—I feel that I may reasonably be expected to take as my special subject that of engineering education.

Ten years ago an important step was taken by the Institution in the inauguration of our own examinations. This was a great step, especially for mechanical engineers, who might always be trusted to take care that the vital requirements of the practical side of their profession were never subordinated to mere theory, since it is in regard to their practical work that the final word must always be said as to success and failure in mechanical engineering. Although in the year of their institution (1913) there were only 18 candidates at these examinations, the number has risen rapidly until this year it has exceeded 500. I venture to say that our examinations, as a result of the care which is exercised by both professors and members of council, will compare favourably with those of any other body, not only in fairness of the results, but what is even more important, in the prevention of cramming and consequent acquisition of mere superficial knowledge.

The Student Class and the Graduate Class.—One important innovation has this year come into operation, and that is the institution of the class of students as distinguished from the class of graduates. A student class has been formed which all those who have adopted mechanical engineering as a profession are allowed to enter between the ages of 16 and 25. Before being recognised as a student they must have either passed what was previously the examination for graduates or be able to present equivalent certificates of University matriculation standard. This class is more or less equivalent to the old class of graduates. The name graduate is still retained, but is now employed in its correct sense and indicates not merely those who have qualified by a University degree, or by passing our own examination for corporate membership, but have already proceeded to an extent satisfactory to the council in their practical training at engineering works. In other words, they must have given proof that while they have attained a standard in engineering science previously demanded of corporate members, they are getting practical experience fitting them in due time to be raised to that. This enables the council to consider the advancement of graduates to the rank of associate members solely on the grounds of their practical knowledge and experience. As President, I appeal to all members controlling technical staffs to give preference to our own graduates in selecting young men for employment.

* Abstracted. Delivered on Friday, October 20, 1922.

This step has led to other important changes. From October, 1913, to April, 1920, candidates for election over thirty years of age were not required to pass the examinations, and after October, 1920, the age limit was raised to thirty-three years. The council has now power, when there is a doubt as to the standard of attainments of a candidate for election, to require such a candidate (although over thirty-three) to pass certain selected technical subjects of our examination or to present a thesis. Since the choice between the thesis and examination rests with the candidate there is no hardship inflicted on busy men who hold administrative positions and could not be expected to go back to school.

Recognition of Professional Status of Members of the Institution by other Authorities.—The high standard of the scientific as well as practical knowledge of our members is now recognised all over the world, and it is realised that membership of our Institution has become a coveted distinction to be earnestly sought and jealously guarded. One of the most remarkable results of this is the change of attitude of official bodies generally, and especially of Government and the Military Services, this being enhanced no doubt by the general change of conditions since the war.

Both the Air Ministry and the War Office have approached the Institution for co-operation and assistance in regard to the engineering side. There are two reasons for doing this, the first being the guarantee afforded in each respective service that the men employed in engineering work by them should be properly qualified, and the other that men who are being prepared for the emergency of war may, by admission to the Institution and passing its examinations, secure recognition from mechanical engineers all over the world as to their status and acquirements when they return to civilian life.

The Air Council has recently started a scheme for granting short service commissions in the Royal Air Force to young men qualifying for associate membership of the Institution, which includes practical training in civilian works as well as in the Royal Air Force. The Institution examinations take a recognised place in the scheme. (*Vide* Air Publications, No. 894.)

The Army Council accepts the Associate Membership Examination (or its recognised equivalent) as the only qualification for corps pay for officers of the Royal Army Service Corps and of the Tank Corps (Technical Branch). It also accepts the examinations as one of the three alternatives (with Inst.C.E. and I.E.E.) as a qualification for engineer pay for officers of the Royal Engineers. The Tank Corps has met our requirements by arranging special courses for its officers at the Artillery College, Woolwich, to prepare them for the Associate Membership Examination. (*Vide* Royal Warrant, Army Order 324/1919, pages 12 and 13.)

Ex-Service Engineers.—The idea of a thesis previously mentioned was adopted as the result of the application of a number of ex-service candidates, a large number of whom were wounded in the war and were entitled to receive special consideration in their endeavours to resume their work of training as engineers. The education of these ex-service candidates had been seriously interfered with during the war, and the Examination Committee undertook the task of interviewing more than 50 of such candidates, the remainder being seen by members at home and abroad. It is sufficient to say that the system of theses, in each case written without the aid of books or notes, and in the presence of some duly-qualified member of our Institution, has been an unqualified success as a satisfactory test of the qualification of the candidate—only a small proportion having failed to satisfy the examiners.

National Certificates and Diplomas in Mechanical Engineering.—During the year the Board of Education has put us in a position to share with it in the control of the education, not merely of a large number of those who become members of the Institution, but of those engaged in the work of mechanical engineering attending the day or evening classes of technical colleges or schools—that is to say, pupils, apprentices, improvers, and skilled mechanics as well as draughtsmen, foremen and managers of engineering works.

The initiative in this matter came from the Technological Branch of the Board of Education. It is important that every mechanical engineer at home or abroad, who has any influence with young men employed by him or the responsible task of selecting employees, should grasp the essential conditions of what are now National Certificates in Mechanical Engineering, and when grasped give full weight to their importance. I will briefly state the necessary requirements for such certificates, which are as follows: (1) In the first place a minimum of two years' attendance (but usually three) at courses approved jointly by the Institution and the Board of Education by the Board's engineering inspectors, must be presented. (2) Results of the usual annual examination of such schools must be duly recorded and vouched for by the principal of the school. (3) Laboratory notes duly certified showing the candidate has had a proper course of laboratory instruction and kept notes of his work throughout the period of training. (4) The last test is the final examination itself in each different grade.

Whilst all the certificates are presented and examinations conducted by the schools themselves the Institution appoints the assessors, just as the Board of Education appoints the inspectors, and to the Institution such assessors are entirely responsible for considering all papers, reviewing and supervising all results. All such results are submitted to the Joint Committee of our council and the Board of Education, all doubtful cases on the border line being specially considered.

Of the 1,250 candidates who have presented themselves in the first year from 48 technical schools, 51 per cent. have been awarded national certificates. It may be said that the 72 schools now admitted to the scheme as duly qualified, and heartily co-operating in it, represent with a very few exceptions, all the technical schools of the country.

Local Branches.—Probably next in importance to the progress of education and technical requirements comes the advance which has been made so that the various centres of engineering industry should as far as possible have equal advantages with the London members in regard to meetings and discussions.

The first steps towards this were taken in 1914, by the appointment of honorary local correspondents to arrange for meetings and discussions in the provinces. It was, however, not until after the war (in 1921) that local branches were inaugurated; these at present number four. It is expected that branches covering other districts will be formed in the near future. It is very gratifying to note the enthusiasm and success of these branches, two of which have already started graduates' sections.

The council has also evinced its anxiety to keep in touch with members residing abroad, and has established Advisory Committees in various parts of the British Empire. It is thought that these committees will keep distant members in touch with the Institution and with each other, and will be useful in bringing to the notice of the council any matters affecting their interests. The committees have also been found of great assistance to the council when considering applications for joining the Institution.

Another step forward taken for the first time during the past year is the holding of examinations in provincial centres; they will also shortly be held at several places abroad.

A great step has been taken in the extension of facilities of our library, especially for those who are only occasionally able to use the Institution house. Any member is now able to obtain books from the Institution on loan, and to aid members in doing this each journal contains a brief notice of new books added to the Institution library. But beyond this, our energetic library staff, directly a request for information is received from any member, promptly institutes a search and transmits without delay any information available on any subject connected with mechanical engineering.

Research.—In the year 1879—that is nearly fifty years ago—the Institution first appointed a Research Committee, and devoted some of its funds to this purpose, and since then the sum of between 13,000*l.* and 14,000*l.* have been expended on research from the Institution funds, taking such subjects as alloys, cutting tools, friction and lubrication, gas engines, marine engine trials, hardness, steam nozzles, steam and refrigeration. These researches have undoubtedly not only greatly enhanced our reputation, but have been of the greatest value to the engineering world. In the year 1901, as the result of continuous pressure on Government, partly by members of our own Institution, the National Physical Laboratory was established, and later on, in 1915, as a natural corollary, and partly owing to the war, the Government Committee of Scientific and Industrial Research. The record of both National Physical Laboratory and the Government Department for Research is one of which we may well be proud, although the establishment of both was far too long delayed considering the importance of our country in the world of physical and mechanical science.

In view of present-day demands, the council will have to consider most carefully to what extent, if any, they will be able to contribute further to researches which may well be left in the hands of the above-mentioned bodies.

Finance.—The Institution building was erected in 1898, and with the Princes-street extension (which was completed in 1913), has cost the total sum of 100,793*l.* The property is held under leases from the Ecclesiastical Commissioners and Dr. Williams' Trustees, the principal lease expiring in 1974. In 1917, the council (at the suggestion of Mr. Mark Robinson, then chairman of the Finance Committee, to whom the Institution will for ever be under a deep debt of gratitude) instituted a Leaseholds Amortisation Sinking Fund by setting aside the sum of 20,000*l.* in 5 per cent. War Stock, and it was estimated that this sum, with all accrued interest, would realise about 202,000*l.* at the end of 1973. The incidence of the war has, however, so completely changed the aspect of housing, rating and finance, that it seems advisable to consider the question of enfranchisement, that is to say, purchase of our freehold. Otherwise, when our lease ends the whole of our splendid building, with all improvements and additions, will have to be handed over to our landlords, and we may be turned into the street with only our books, furniture and models. The Ecclesiastical Commissioners are not prepared to sell any of their property, but we are advised they would entertain a proposal to extend our lease for 999 years at, however, a very considerably increased ground rent. Dr. Williams' Trustees cannot move without the consent of the Charity Commissioners, and it is unlikely that they would view sales from any other standpoint than that taken by the Ecclesiastical Commissioners. Any improvement or extension carried out by the Institution to the building or its amenities would enhance the value of the messuage in the event of the freehold or a 999 years' lease being obtainable, and it is feared that this would reflect adversely on the purchase price or ground rent. It is hoped, however, that legislation already before Parliament may be carried through before many years to enable the Institution to become freeholders of their own building on equitable lines; funds should, therefore, be earmarked for this purpose.

With regard to our existing financial obligations, a sum of 34,025*l.* was raised in 1911 on 4 per cent. debentures for the Princes-street extension. These debentures (which could be repaid at the option of the council in 1921) are redeemable on or before December 31, 1931. Against this indebtedness there has been set aside a sum of 13,400*l.* in trustee securities, and the council is annually

adding to this figure. It has been urged at council meetings that the time has now come to secure independence and redeem these debentures when we have the funds to do so.

From 1910 (notwithstanding the drop during the war), our membership of 5,700 had reached 8,196 by the end of 1921, and is to-day rapidly approaching a total of 9,000. With the increase of membership, and with its activities, the work of the staff has enormously increased. The number of council and committees meetings in the same period has increased from 51 to 140. This has naturally led to an increase of staff which now includes two assistant secretaries, who were appointed with the new secretary in 1919. In view of these circumstances I am satisfied that the increase in staff expenses shown by the annual report is fully justified.

I cannot regard without apprehension the inadequacy of the funds set aside for pensions. In 1914 a small fund was started to which 100*l.* was voted per annum up to 1917, and since that day 1,000*l.* per annum has been allocated for this fund. The annual pension expenditure is to-day between 700*l.* and 800*l.*, while only a few years ago it was practically nil, and one of the things that should be done without delay is to see that capital is provided to meet the future in this respect.

Scientific Knowledge and Invention.—In his able presidential address already alluded to, Mr. Ellington quoted Joshua Field, F.R.S., fourth president of the Institution of Civil Engineers, as saying (just after the death of our first president): "George Stephenson was well known to us all. He was president of a kindred society, the Institution of Mechanical Engineers. That Institution principally directs its attention to new inventions in the mechanical and manufacturing processes whilst the communications brought before us (the Civils), are chiefly accounts of executed works in civil and mechanical engineering."

This, to my mind, was a very fair statement, at any rate at the time, of the respective provinces of the two Institutions, and as I have devoted myself since I have been in engineering practice to inventions of various kinds, I embrace this opportunity of saying how the education of which I have been speaking is to-day of vital necessity for invention in mechanical engineering, and also of correcting some prevalent misconceptions as to the real nature of invention.

The word invention, as you know, comes from the Latin *invenire*, "to come upon." The poet Goethe after asking, "What is invention?" goes on to answer his question by saying, "Invention is the end of seeking." All progress at any rate in mechanical science must be in the nature of invention. Every fresh step taken, in which new ground is trodden, every new device or new mechanism or new machine of changed form, in which movement of parts differ, or even if the object attained is different, can only result from the exercise of the inventive faculty. If a man cannot do more than alter the dimensions of machinery which he is constructing, he cannot be called an engineer at all.

An average of 30,000 patents is taken out each year by inventors searching for new devices and in the hope of securing some new results. Inasmuch as anything that has been patented within the previous fifty years (beyond which search is not conducted by the Patent Office) is considered as anticipated, it is easy to see what a hopeless task is being attempted by the ignorant and uneducated inventor. Anyone who studies the *Patent Journal* week by week must see that even to-day the attempts of a large number of inventors would be ludicrous if they were not in most cases pathetic. It is often said that the Patent Office should not proceed with and grant ridiculous inventions of this kind, but it must be remembered that some of the greatest inventions at first were regarded as absurd and impossible even by able men, and I have only to quote the history of the locomotive or the Bessemer process as cases in point.

It is, of course, such absurd productions that bring invention in general into ridicule. The truth, however, must be told that engineers in practice in the course of their work constantly spend large sums of money on inventions which, if they are more plausible, are not less impossible than many others. In 99 cases out of 100, a sound training in principles of physical and mechanical science would keep a man on sound lines and enable him to use that power which most of all distinguishes him from a mere animal, namely, imagination. James Watt is a wonderful example of a man of sound training and education applying himself to the solution of great problems, not merely the great problem which resulted in a separate condenser, but his wonderful mechanisms for parallel motion.

The very first clause in the objects of our Institution is stated: "To promote the science and practice of mechanical engineering, to give impulse to inventions *likely to be useful* to the members of the Institution and to the community at large." I emphasise "likely to be useful" because this object of the Institution is just as important as any of the others, and I still hope to see the subject of invention treated in the same scientific manner, as clearly one of the most important of our objects.

Whatever impulse in the way I have suggested, or in any other way, our Institution may be able to give to invention, it must not be overlooked that by far the greatest inducement to invent is the protection afforded by the Patent Office. A patent is granted, not as some people think, because the Government has the slightest interest in that individual inventor, but simply and solely in the interests of the public, so that by the inducement of the reward in the form of a monopoly for a certain number of years the public may in return reap the fruit both of the genius of an inventor and of the expenditure of money by the capitalist necessary to produce and bring to fruition a successful invention.

From time to time the Patent Laws have been modified and improved, and our Institution has always been ready to take its part for the protection of the inventor, at any rate in engineering matters. Only recently (1918) when an attempt was made to introduce undesirable modifications in the Patent Law a strong representative committee was formed of different Institutions, and our own president at the time (Mr. Longridge) took the chair at the meetings on the subject, with the result that the most objectionable features were removed. The alterations contained one clause of the greatest value, namely, the increase of duration of a patent from fourteen years to sixteen, thus bringing the time nearly to that of the American patent, which is granted for seventeen years. There are certain other matters in which our Institution might use its influence suggested to me by a friend of experience. One of these concerns the revocation of a patent, another designed to effect a clear understanding of the relation between employer and employee in matters of invention, another the rights of the Controller of Patents in regard to the power of refusing a patent for something which, although it may be new is not in his opinion an actual invention, and lastly the introduction of something sorely needed between a patent and a design as provided for by German Patent Law.

To-day, when there is so little opportunity in mechanical engineering directions of far-reaching discovery and consequently of a master patent, a cheaper patent for a short time (say a period of five or six years), ought to be granted for an improvement which may be of great value, although the matter may be a comparatively small one. For this a small fee might be charged (say 1*l.* a year), enabling the inventor to introduce small improvements for which he would not receive adequate protection by registration of design, but which would be at once copied. Thus, after great expense in the way of experimenting, devising and making patterns, he finds a week or two afterwards that his actual device has been copied, even put on the market, even perhaps been actually used with a trivial alteration as a pattern to mould from.

Conclusion.—Amongst many subjects of interest and importance is the relation of kindred Institutions to ourselves. Following the words of Joshua Field, which I have already quoted, are these, "Our two societies embrace the whole science, and by combining their efforts with mutual goodwill and a perfect understanding they may, and do, confer great benefits on the public." This was nearly seventy-five years ago, and shows the splendid spirit in which the birth of our Institution was welcomed by the premier engineering Institution of Civil Engineers. I rejoice to say that not only have those feelings of friendship and goodwill, so happily expressed, always existed, but we are proud to think that we have ourselves likewise extended the same welcome to new engineering institutions as they have arisen. At the present time there is a Committee of the four leading Institutions—Civil, Mechanical, Electrical and Naval Architects—engaged in considering how we can draw still closer together and ultimately embrace in harmonious relationship all the junior institutions. I will not anticipate the labours of that committee, and speculate how far they will co-ordinate all engineering examinations, or what they will achieve. In America the great Institutions are happily united in one large building. I venture to express a hope that, if possible, the Civils and ourselves may approach so closely that, by means of subways beneath or bridges above, we may possibly unite our buildings, so that on great occasions each Institution may have the benefit of the united structures.

I will conclude my somewhat lengthy address by expressing my deep sense of the honour my fellow members have conferred upon me in electing me to the office of president.

When I joined the Institution nearly fifty years ago as a very young man, the idea of this honour would have been beyond the range of my wildest ambition. There are some things which appeal to one's imagination more strongly than others, and the greatest pride a man can possibly feel is in the recognition which he receives at the hands of those who know him best and who are engaged in the same life work as himself. I cannot claim the eminent position of many of my predecessors, but I can claim to be second to none of them in my devotion to our Institution. As I pass in review the wonderful advances of engineering during the last fifty years I recall the great men with whom my profession has brought me in contact and by whom, in a number of cases, I have been honoured with personal friendship, especially in the twelve years that I have spent on the council of this Institution, many of whose members have been my warmest and best friends. For all this and much besides I can truly say that I would not have chosen my career in any other than the great and learned profession of engineering to which I am proud to belong.

Dolomite for Refractories.—If the lime in dolomite can be combined so as to render it non-slaking and at the same time hold up the refractoriness of the material, the abundant deposits of dolomite in America would be rendered available for extensive use as a basic refractory, according to the United States Bureau of Mines. Briquettes containing 90 per cent. dolomite and varying percentages of iron oxide and clay have been burned by the Bureau of Mines at the ceramic experiment station, Columbus, Ohio. Slaking time tests were run and the results plotted on a triaxial diagram. The slowest slaking mixture was selected for making into bricks which were burned to a high enough temperature to render the lime inactive. Bricks with a high fusion temperature and high specific gravity, great mechanical strength, and low porosity were the result. The work is being continued, using varying percentages of dolomite to determine the non-slaking areas over the entire field.

CATALOGUES.

Electrical Fittings.—Prices and particulars of lamps, switches, cables and all the various fittings for electrical wiring are given in a catalogue received from Messrs. Donovan and Co., 47, Cornwall-street, Birmingham.

X-Ray Apparatus.—A variety of apparatus for X-ray treatment is described in a catalogue recently issued by Messrs. Watson and Sons, Limited, Parker-street, Kingsway, London, W.C. 2.

Lifting Block.—An electric block, made in ½-ton to 5 tons lifting capacities, and shown in use with various arrangements for traversing and swinging the load, is described in a catalogue received from Messrs. Stavers and Stavers, 2, Cockspur-street, London, S.W. 1.

Foundry Equipment.—Cupolas, crucible furnaces, steel converters, ladles and similar plant for iron, steel and brass foundries, of all sizes, are shown in a catalogue issued by Messrs. George Green and Co., Keighley, who contract for partial or complete equipments.

Pneumatic Tools.—A new general catalogue of their pneumatic tools, fully illustrated, and with tabulated particulars of the various types made, has been issued by the Consolidated Pneumatic Tool Company, Limited, Fraserburgh, Scotland, and 120, Piccadilly, London, W. 1.

Brush Holder.—A form of holder for carbon brushes, which is stated to have been adopted as a standard by a number of British dynamo and motor manufacturers is described in a catalogue received from the Standard Carbon Brush Holder Company, Limited, 3, Frederick's-place, Old Jewry, London, E.C.

Electric Wires and Cables.—Wires, cables, cords, &c., including many types of flexibles, and also bare round copper and wireless aerials, are listed with prices and all usual particulars in a catalogue received from the Saxonia Electric Wire Company, Limited, Greenwich, London, S.E.

Power Stations.—A paper by Mr. L. C. Kemp, B.Sc., on the choice of steam conditions in power stations has been reprinted from *The Electrician*, by the English Electric Company, Limited, Queen's House, Kingsway, London, in a convenient size uniform with their catalogues.

Condenser Tube Packing.—The applications and effects in checking corrosion of metal packing rings, made up of layers of spiralled babbit foil, for condenser and similar tube ends are described in a catalogue received from Crane Packing Company, Cuyler-avenue, Chicago, Ill., U.S.A. There is some interesting information on the subject of faulty tubes in this catalogue.

Motor Vehicles.—A petrol-engined chassis of 25 h.p., which may be fitted to carry a 30-cwt. load or 16 to 20 passengers, is fully described with excellent line drawings of the principal parts in a catalogue received from Messrs. Sheffield Simplex, Limited, 20, Conduit-street, London, W. 1. Another form is also supplied with the same machinery, but with a larger frame, and geared for a slower speed, to carry a load of 40 cwt.

Mining Equipment.—Tub-decking constructions, fans, single to treble deck cages, motor-driven air compressors, air-driven electric haulage gears, boiler-house plant and other mining plant are described in some detail in the catalogue issued by the Brightside Foundry and Engineering Company, Limited, Sheffield, who report the receipt of an order for a large hydraulic tub-decking plant for a new Yorkshire colliery.

Signalling Apparatus.—We have received from Messrs. Tyer and Co., Limited, Ashwin-street, Dalston, E. 8, a presentation copy of the "Railway Signal and Permanent Way Engineers' Pocket Book." This excellent little volume, compiled by the locomotive Publishing Company, Limited, Amen Corner, E.C. 4, deals with a large variety of signalling systems and apparatus, Messrs. Tyers' products naturally figuring largely in its pages.

Transformers.—The series of technical booklets issued by Messrs. Johnson and Phillips, Limited, Charlton, London, S.E. 7, on practical questions connected with transformers has been completed with the publication of the eleventh and twelfth numbers. Of these, No. 11 deals with transformer losses, efficiency and regulation, and No. 12 with the parallel operation of transformers. Lest the general title "Transformer Abstracts" should convey a wrong impression we may say that the publications might be described as a handbook of practical and technical information, in twelve chapters. A sound elementary knowledge on the part of the reader is assumed, and anyone possessing that knowledge and interested in the subject of transformers, can study these handbooks with considerable advantage.

Accumulators.—Messrs. C. A. Vandervell and Co., Limited, Warple Way, Acton Vale, London, W., who for many years have specialised in the production of lighting, starting and ignition equipments for motor cars, motor launches, aircraft, &c., are now supplying a series of accumulators specially intended for use with wireless apparatus. One of the special features of these accumulators, which are known as C. A. V. Willard batteries, is the use of threaded rubber insulation between the plates. It is pointed out in a folder recently received from the firm, that the rubber insulation is not affected by the acid and does not soften, warp, or crack as wood does; it is also uniformly porous so that it does not interfere with the action of the electrolyte. Particulars are given of nine sizes with capacities ranging from 12 ampere-hours to 112 ampere-hours, all sizes having an E.M.F. of 6 volts. A long list of stations in various parts of the country where these batteries can be recharged is also given.

"ENGINEERING" ILLUSTRATED PATENT RECORD.

SELECTED ABSTRACTS OF RECENT PUBLISHED SPECIFICATIONS UNDER THE ACTS OF 1907 AND 1919.

The number of views given in the Specification Drawings is stated in each case; where none is mentioned the Specification is not illustrated.

Where inventions are communicated from abroad, the Names, &c., of the communicators are given in italics.

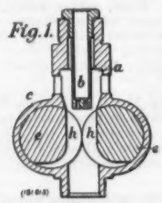
Copies of Specifications may be obtained at the Patent Office, Sales Branch, 25, Southampton Buildings, Chancery-lane, W.C., at the uniform price of 1s.

The date of the advertisement of the acceptance of a Complete Specification is, in each case, given after the abstract, unless the Patent has been sealed, when the word "Sealed" is appended.

Any person may, at any time within two months from the date of the advertisement of the acceptance of a Complete Specification, give notice at the Patent Office of opposition to the grant of a Patent on any of the grounds mentioned in the Acts.

GAS ENGINES, PRODUCERS, HOLDERS, &c.

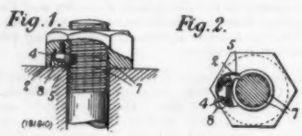
181,813. H. Shephard, Coventry. Venturi Tubes. (6 *Figs.*) March 18, 1921.—The invention consists in the application to the nozzle of a gas furnace burner of a variable venturi tube of the kind in which the throat of the venturi air tube or passage is constituted by the adjacent recessed peripheries of two cylinders which make peripheral contact with each other and are arranged to rotate in opposite directions within a casing carried by or formed integrally with the air tube. The air tube *a*, which is screw-threaded at its lower end for attachment to the furnace and carries the gas nipple *b* at its upper end, is formed within an open-sided casing *c*, which is normally closed by a cover-plate. The casing *c* receives two cylinders *e*, *e*, which when introduced therein are in peripheral contact with each other



and a close working fit within the casing. The cylinders *e*, *e* are geared together. Each cylinder *e* is formed with a peripheral recess *h* which is of tapering depth in the direction of the circumference and of semi-circular shape at any cross-section, so that at any point of contact of the two cylinders throughout their range of movement a circular passage is formed between them, the diameter of which can be infinitely varied within the limits of such movement. The rotation or setting of the cylinders to adjust the effective diameter of the air-tube as described may be either effected directly by means of a hand wheel or a lever secured to a projecting spindle on one of the cylinders, or indirectly through suitable connections from some distant point. (*Sealed.*)

MACHINE AND OTHER TOOLS, SHAFTING, &c.

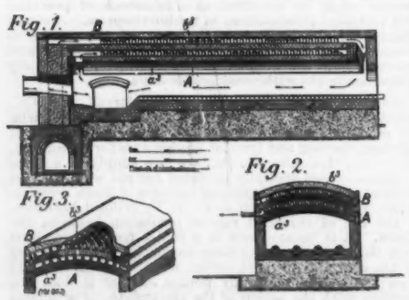
181,910. J. F. Bennett, London. Nut Locks. (2 *Figs.*) December 13, 1921.—The invention has relation to nut locks in which the nut is locked to its bolt by rack and pawl mechanism, the pawl being mounted in the nut and the rack constituted by grooves or indentations formed in the bolt thread. In accordance



with this invention, the pawl 5 is actuated by a spring 4 and is released by a ball 8 contained in a hole in the wall of the pawl recess and projecting beyond the exterior face 2 of the nut, and the rack consists of parallel rows of indentations 7 formed at the base of the thread. (*Sealed.*)

MINING, METALLURGY, AND METAL-WORKING.

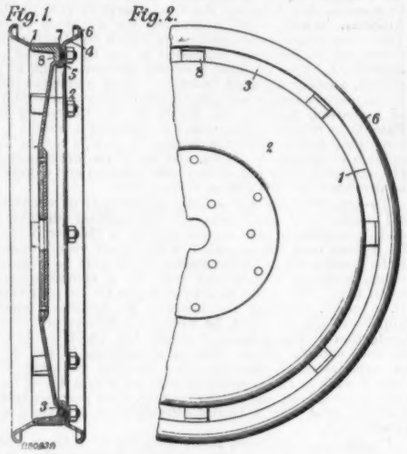
181,863. The Wellman Smith Owen Engineering Corporation, Limited, London, and A. V. Kemp, London. Metallurgical Furnaces. (3 *Figs.*) April 1, 1921.—This invention relates to furnaces for metallurgical purposes of the kind in which there are, above the roof of the furnace proper, two passages one over the other, one for the air for effecting the combustion of the fuel-gas, and the other for the exhaust gases,



so that the air is preheated by the heat from the furnace proper and by the heat from the escaping exhaust gases. Baffling arrangements are provided in the passages for absorbing and giving up heat. According to this invention, these baffling arrangements are formed by building up the roof of the furnace proper and the roof of the air passage so that brick slabs a^5, b^5 at intervals project into the passages A, B for air and exhaust gases respectively. (*Sealed.*)

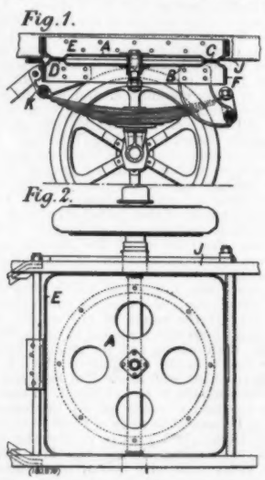
MOTOR ROAD VEHICLES.

180,931. Steel Stampings, Limited, A. T. Forty, and T. A. Morris, Cookley, near Kidderminster. Disc Wheels. (3 *Figs.*) July 18, 1921.—This invention relates to disc wheels for vehicles. According to it, bracket-like supporting heads are provided for the securing bolts, the heads being spaced at intervals around the rim and adapted to engage



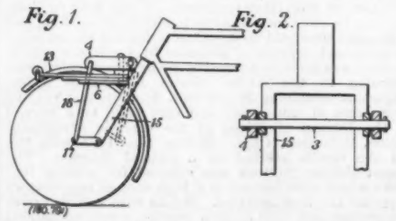
one part of the rim so as to assist in supporting same. The rim of the wheel is made in two parts. One part 1 is made integrally with the disc 2 of the wheel. Between the part 1 and a conical portion of the disc 2 an annular recess 3 is formed in the disc. The other portion 4 of the rim is provided with a flange 5 of L-section adapted to engage around the portion 3 of the disc 2. (*Sealed.*)

180,879. S. E. Alley, Westminster, London. Trailer Vehicles. (4 *Figs.*) May 4, 1921.—According to this invention, the turntable of a steering axle consists of two discs A, A centrally dished and having annular flange-like peripheral portions C, D. The discs are arranged with their flange-like peripheries taking bearing upon one another. Axially in one disc is arranged



a king-pin or pivot, having a bearing in the other disc. The peripheries of the discs are extended, and the extensions formed with brackets or flanges E, F for attachment to the usual side and cross-members J of the vehicle, or the extensions may in themselves form main or auxiliary cross-members. To the underside of the lower disc are attached brackets K to take the springs. (*Sealed.*)

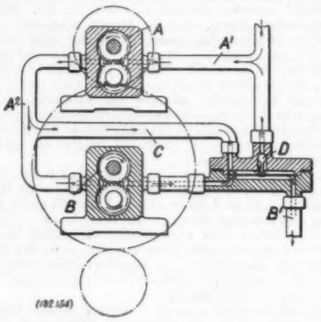
180,791. E. E. Tavener, Walthamstow. Spring Suspensions. (2 *Figs.*) March 16, 1921.—According to the present invention, means for the spring suspension of a vehicle wheel,



such as the rear wheel or front wheel of a cycle or motor cycle, comprises an arm or lever pivotally mounted at one end on the vehicle frame, a flat or laminated spring at one end rigidly connected to the arm or lever and supported at its other end from the frame of the machine and a pair of links connected together at one end, one of these links being connected to the forks and the other to the arm or lever remote from its pivot, the wheel spindle being carried on the links. A pair of arms 4 is mounted so as to pivot at one end on the spindle 3 carried by the front forks 15. At their outer ends the arms 4 are connected by links 16 to the wheel spindle 17 and a pair of links connect these to the forks 15. The laminated spring 6, of greater length than the arms 4 and which may be mounted between them, is rigidly connected thereto. At its opposite end the spring is connected to the mudguard 13. When the road wheel is subjected to shock, the arms 4 and spring 6 turn about their common pivotal axes so that the springs are flexed. (*Sealed.*)

PUMPS.

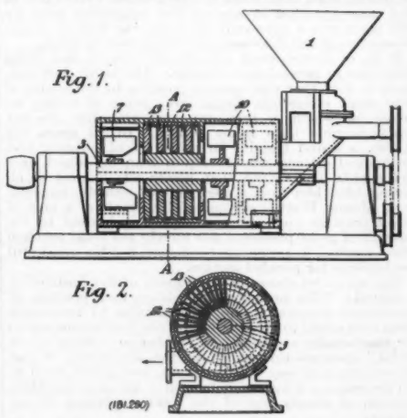
182,154. Vickers, Limited, Westminster, London, and W. Pool, Crayford. Pumping Devices. (6 *Figs.*) January 28, 1921.—This invention relates to pumping devices of the kind comprising two pump elements (preferably of the gear type) arranged in series, and so driven or proportioned that the delivery of one pump element is greater than that of the other which is supplied with fluid by the first pump element. According to the invention, the surplus fluid from the first or greater delivery pump element A passes through a bye-pass or pressure balance valve D, which is acted upon by the fluid in the delivery conduit of the first pump element and by the fluid in the delivery conduit of the second pump element B, which acts as a measuring device or meter to pass the quantity of fluid required per unit



of time. This valve D is preferably of the diaphragm type and is so arranged that the pressures in a branch conduit C from the delivery conduit A^2 of the first pump element and in the delivery conduit B^1 of the second or meter pump element are opposed to each other, so that as either predominates the moving member of the valve D will be displaced to vary an orifice through which the excess liquid in the branch conduit C can escape back into the inlet conduit A^1 of the first pump element. By these means the pressure in the branch conduit C, and therefore in the conduit A^2 between the two pump elements, is kept equal to the pressure in the delivery conduit B^1, that is to say, equal pressures are maintained at all times on both sides of the second or meter pump element, and thus there can be no slip or leakage back. (*Sealed.*)

STEAM ENGINES, BOILERS, EVAPORATORS, &c.

181,290. The Powdered Fuel Plant Company, Limited, Westminster (*the Assignees of Société Anonyme La Combustion Rationnelle, Paris, France*). **Powdered Fuel Combustion.** (2 *Figs.*) October 20, 1921.—This invention is for improvements in pulverising or grinding apparatus for pulverising coal and reducing it to the finest possible powder. According to this invention, the pulverising apparatus is, broadly speaking, constructed like a multiple stage steam turbine, and comprises a rotor and stator, each provided with a large number of vanes 12, 13 of uniform shape from end to end and disposed so that the angle between adjacent vanes is small and the vanes have their operative and broader faces parallel with the axes of the



rotor and stator and move rapidly relatively to and in close proximity to one another. The closed casing containing the parts mentioned is provided at one end with means 1 for supplying to it the material to be pulverised, an air inlet at the same end, and a fan 7, which is conveniently mounted on the rotor shaft 3, for causing the air and the material carried in suspension by it to traverse the casing longitudinally of the rotor and stator. The apparatus described may be used only for the final stages of pulverising and may be used in combination with a preliminary pulverising device 10, for example, of the hammer type, such preliminary device being used to reduce the raw material to such a state that it is suitable for treatment by the apparatus described. Preferably the preliminary pulverising device 10 is incorporated with the final pulverising means so as to constitute a single apparatus for effecting the complete treatment of the raw material. (*Sealed.*)